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GEOLOGICAL SURVEY OF NEW JERSEY.

REPORT

ON

FORESTRY.

1896

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THE JOHN L. MURPHY PUBLISHING COMPANY, PRINTERS.
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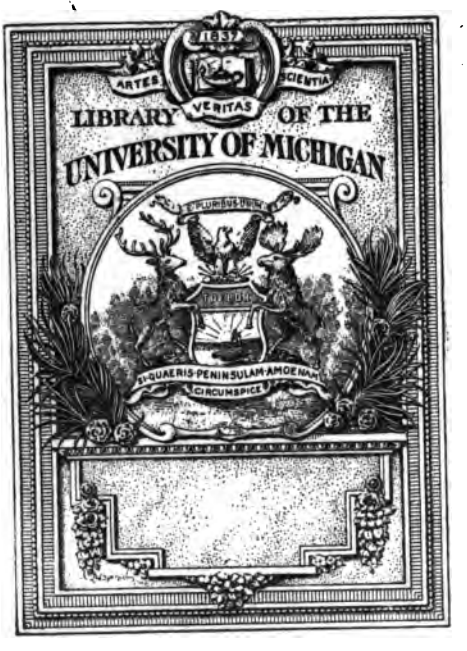
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REPORT ON FORESTRY IN NORTHERN NEW JERSEY.

BY C C. VERMEULE.

Last year we began a detailed survey and inquiry into the physical condition of the forests of Northern New Jersey, and reported thereon in the last Annual Report. This work has since been extended to cover all of the Highlands, the Central Passaic valley, and that portion of the country east of the Watchung mountains which is included in Bergen, Hudson and Essex counties. As a result of this work we now know the location and extent of all forested areas, and the size, varieties and character of the growth. The forest is considered in these studies to include the following classes:

1. Brush or stump land, to include no areas intended to be cleared and cultivated.
2. Old clearings formerly cultivated, but now growing up to timber.
3. Young growth, in which class was included all timber less than six inches diameter, the approximate age, size and height being noted.
4. Large timber, including all over six inches in diameter, the diameter and height being noted as before.

Without attempting any strict botanical classification, the varieties of timber have been designated as follows:

1. Deciduous, with the prevailing varieties indicated.
2. Coniferous, classified as pine, cedar, hemlock, &c.
3. Mixed deciduous and coniferous.

Notes were kept of the general character of scattered growth over lands under cultivation, also of the general condition of the forested areas, and of any remarkably large trees, any original forest, planted timber, brush land which seems incapable of producing timber, the

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succession of growth, &c. Information was also collected as to the value per acre of stump land of twenty-years or thirty-years growth, and all heavy timber of various kinds; also of the testimony of reliable persons as to how the amount of timber now standing compares with that of previous periods, and of how the growth on slopes of hills compares with that in the valleys or on the top of plateaus.

It will be noted that the inquiries were of the most practical kind, and it is believed that the information obtained will be of value in reaching an understanding of the actual economic condition of our forested areas. Thus far they have developed the fact that there have been no important changes either in the limits of cultivated land, or in the proportion of forested and cultivated areas, since the topographical surveys were begun in 1877. There have been minor changes, and a few old clearings of small area have been allowed to grow up, the areas thus added to the forests being just about offset by that which has been brought under cultivation, likewise in small, scattered parcels.

The topographical maps showed forested lands as distinguished from those under cultivation. They made no attempt to indicate the varieties, size or condition of the timber. There is very little land in the State which, if left uncultivated, does not spontaneously produce, in a few years, a fairly good growth of timber; consequently, the land represented as forest on the maps, for which the surveys were completed in 1887, ranges from brush to good timber of from forty to fifty years growth, and for the most part every gradation of growth is represented in due proportion. The examinations made during the past year have attempted to differentiate this growth into varieties of trees, age and size, as we have explained.

Like almost every other physical feature of the State, the forests may be classed broadly into five divisions corresponding with the geological formations, and each of the three northern divisions must be subdivided into glaciated and unglaciated districts. There is a marked difference in the proportion of forest area, and also a less marked difference in the varieties of timber north and south of the terminal moraine line. Consequently we can most conveniently consider the forests by the several topographical divisions adopted and followed in the "Physical Description" of the State, published in 1888.

For convenient reference, and in order to give something like completeness to this present progress report, we have incorporated herein the results of the two years' work.

THE HIGHLANDS.

The region known as the Highlands has been often described in the reports of the Survey. Its boundaries are indicated on the accompanying map, and it is the region of Archean or gneissic rocks. The most significant geological subdivision in connection with forestry is into two districts; first, the northeastern or glaciated, and second, the southwestern or unglaciated Highlands. The former being denuded of soil on the ridges, and the valleys filled with gravel, boulders, &c., by the action of the great ice sheet, is less adapted to agriculture, consequently more generally forested than the southwestern portion, which has smoother ridges, well covered with soil, and clean, unlittered valleys.

We may indicate the difference by comparing the percentages of forest areas in two classes of townships, each typical of one of these subdivisions of the Highlands.

GLACIATED NORTHEASTERN HIGHLANDS.

Township.	County.	Percentage of area in forest.
Byram	Sussex	77
Jefferson	Morris	74
Rockaway	"	72
West Milford	Passaic	74
Pompton	"	76

UNGLACIATED SOUTHWESTERN HIGHLANDS.

Mendham	Morris	30
Chester	"	46
Washington	"	32
Lebanon	Hunterdon	27
High Bridge	"	25
Bethlehem	"	35

It will be seen that the northeastern section has, generally, 75 per cent. of the area forested, as against about 30 per cent. of the southwestern, and this difference is undoubtedly almost entirely due to the different surface conditions brought about by glacial action.

The forests of this Highlands region have a direct relation to the future water-supply of the State, for here lie the splendid gathering-grounds which are already coming rapidly into use for the supply of our cities. We estimate that the Highlands region has in all about

340,000 acres of forest, of which 240,000 acres are in the northeastern, and 100,000 acres in the southwestern section. In our detailed descriptions of each of these subdivisions we shall follow the topographical subdivisions of the Highlands which we adopted in the "Physical Description" published in 1888, beginning on the northwest and passing to the southeast side of the plateau.

FORESTS OF THE NORTHEASTERN HIGHLANDS.

First, on the extreme northwest of this district we have Pochuck mountain, a Highlands region lying detached from the main plateau, like an island, at the eastern side of the great Kittatinny valley. The forests of this region cover about two-thirds of the area, and consist mainly of oak and chestnut, with a considerable amount of hemlock, and some red cedar where old clearings have grown up. A considerable portion of this timber is from 40 to 50 years old, and there are a number of large trees which we shall note later in connection with the forests of the main plateau.

Vernon valley, which separates Pochuck mountain from the main group of the Highlands, is a fertile agricultural district, with a very small amount of forest, but it has a goodly supply of scattering trees which are thrifty and often of large size.

Passing on to the southwest we come to the Alamuche-Pohatcong range, the glaciated portion of which includes the district lying between the Lehigh and Hudson River railroad on the west, and the valleys of the Wallkill and Lubber's run on the east, and extending from Franklin Furnace southwest to the Vienna and Hackettstown road. We find the conditions as follows: From Franklin Furnace southwest to the line of the New York, Susquehanna and Western railroad, this ridge is known as Pimple Hill. The growth of wood is thin, ranging from 2 to 8 inches in diameter, and consisting mainly of chestnut, oak and red cedar, with a few other coniferous trees scattered throughout the whole district. On the high hill near the railroad and north of Sparta, and also along the ravine southwest of Franklin Furnace, the conifers are quite abundant. The growth, however, is principally chestnut and oak, the best of which is from 6 to 24 inches in diameter, and 30 to 55 feet high, a good proportion of these trees being about 12 inches in diameter. Not much cordwood is cut in this section, but the best timber is selected and taken out

here and there as needed. Between the New York, Susquehanna and Western railroad and the highway from Sparta to Pinkneyville there are very few coniferous trees, chestnut and oak being predominant, and somewhat larger than on the Pimple hills, measuring from 9 to 16 inches in diameter and 30 to 55 feet high. Just northwest of Sparta there is a ridge which has been entirely stripped of timber, but there is no clearing in any of this district for farming purposes, and there does not appear to be much cleared land lapsing back into forest. The flat swamp land on the Wallkill southwest of Sparta has some timber, mostly bordering the stream. There are maples and elms 12 to 24 inches in diameter and 40 to 50 feet high interspersed with a good deal of brush, and near the head of the swamp there are a few good white pines, also a number of hemlocks about the headwaters of the stream. The ridge just west of this swamp is well wooded at the north end, the trees being mostly 10 to 14 inches in diameter, but ranging up to 24 inches. The larger trees have been cut out at the southern end of the ridge. There are red cedars bordering the clearings. Tar Hill ridge in Andover township, just east of the Lehigh and Hudson River railroad, is quite well wooded. A small portion has been cut off within the last five years, more within ten years, but generally the timber runs from 6 to 24 inches in diameter and from 30 to 50 feet high, the larger sizes being not very numerous. There are a good many hemlocks and red cedars and a few white pines. On the ridge line between the upper Wallkill and the easterly branch of Lubber's run, and stretching from Sparta to Roseville, the timber is small southward as far as the Gaffney mine, most of the large growth having been cut out. In a few spots trees were noted 18 to 24 inches in diameter, but for the most part they are less than 8 inches. On the west slope there are a great many red cedars and a few hemlocks. In the swamp near Gaffney mine, and also the one just southwest along Lubber's run, there are a good many tamaracks. The hills just east of Stag pond are well wooded on the tops, the trees ranging from 6 to 18 inches in diameter, but the steep slope just east of the pond and its outlet is broken and rocky, and is mostly red cedar and hemlock, with a few white pines. There are also hemlocks and a few white pines on the ridge north of Roseville. A tract of 500 acres at Roseville has had all trees 9 inches in diameter and over cut out. An examination of the stumps showed that oak 60 to 70 years old ranged from 18 to 24 inches in

diameter; from 40 to 50 years old ranged from 13 to 21 inches, being mostly 13 and 14 inches. An oak stump 89 years old measured 24 inches, and showed that for the first 20 years the growth had been very slow. Chestnut 68 years old measured 31 inches, and hickory 90 years old 19 inches. Generally over this tract from Sparta southwest to the Roseville and Andover highway the timber was in good condition. In a few places it had been cut within 3 years; other tracts within 15 years, but a great many of the trees would average from 12 to 20 inches in diameter. Other portions would average from 8 to 15 inches in diameter and from 40 to 55 feet high, although some of the largest timber seemed to be over 60 feet. While oak and chestnut predominate, there is scattering white pine and hemlock throughout.

Between the Andover and Roseville highway, the Sussex railroad and Lubber's run there are a few trees 24 inches in diameter, but for the most part they run from 6 to 14 inches, with a height of from 30 to 50 feet. Near Andover, on the road to Roseville, the timber was 10 to 20 inches in diameter, and 50 to 60 feet high.

The portion of this district extending from Sussex railroad southwest to the highway from Hackettstown to Alamuche is known as Alamuche mountain, and is almost a solid forest. In the Kitattinny valley, between the foot of the mountain and the Lehigh and Hudson River railroad, the country is highly cultivated, the scattering patches of timber being composed of small oaks and chestnuts from 4 to 6 inches in diameter and 15 to 35 feet high. In each grove there are a few large trees from 10 to 30 inches in diameter and 40 to 60 feet high, but most of these larger trees have been cut out for timber or other purposes. There are also a good many red cedars. Along the streams and in the swamp near Alamuche elms and maples prevail, the larger ones being 24 inches in diameter and about 50 feet high. There has been a considerable amount of clearing recently in this swamp, which is being ditched and brought under cultivation as a result of the improvement in the drainage of the Pequest valley. Passing along the road from Andover to Alamuche the first growth seemed to range from 8 to 20 inches in diameter and about 55 feet high; further along, from 6 to 24 inches in diameter and from 30 to 55 feet high, mixed with a smaller and denser growth. About Tranquility timber was noted from 10 to 20 inches in diameter and 40 to 50 feet high, and near Alamuche it

ranged from 4 to 18 inches and from 20 to 45 feet high. It is somewhat similar toward the top of the mountain eastward from Alamuche, and there seems to be a predominance of trees all through the mountains, ranging from 7 to 11 inches in diameter. Trees as large as 20 inches are scarce and scattering, while there is a good deal of young and small growth. There are a few hemlocks on the rocky slope north of Cranberry reservoir, on the end of the mountain north of Alamuche, and near Waterloo, while the swamp north of Waterloo has some tamaracks. South of the road from Alamuche to Waterloo there is a game preserve or deer park, and the wood is chestnut and oak, with some hickory, whitewood, birch, maple and elm. South of the road from Warrenville across the ridge to Saxton Falls, the timber is very short, mostly chestnut and oak on the tops of the hills. On the east slope, where it has not been cut, there is a thrifty growth of chestnut and oak ranging from 6 to 14 inches in diameter. A considerable portion has been cut within 3 years.

Mr. James French, of Waterloo, owns 3,000 acres of timber in this vicinity. Mr. Henry French, his son, reports that they do not cut any cordwood there now, as they do not find it profitable, not being able to compete with the pine cordwood of South Jersey. They sell a good deal of timber on special orders for various purposes, getting out almost anything, for ship-building or other purposes, which may be required. Their tract does not produce timber quite as fast as they need at present. He claims that they work up everything and waste nothing, and thinks that forests are generally in a better condition now than they were 40 years ago, as the larger mills are not cutting much and cordwood is not profitable, that the demand is for the largest timber, and consequently the younger growth is allowed to mature. These gentlemen also peel quite a good deal of butternut, hickory, oak and birch bark for their trade.

It is interesting to note that about 20 years ago Mr. French bought a tract of woodland in these mountains which had been cut off a few years before. This tract has not appeared to grow since, and is said to be not much more than brush at present.

Continuing southwest to the road from Hackettstown to Vienna we find that the timber is inferior in quality. On the slope just northwest of Hackettstown the timber has been cut within three years, but on the hill-top it is 6 to 14 inches in diameter and from

30 to 40 feet high, of chestnut and oak. The timber through this section is in detached tracts, the larger part of the area being under cultivation. Between Hackettstown and Alamuche the timber does not appear to grow well or is too closely cut. West of Alamuche pond the ridge has a larger growth of chestnut and oak, mixed with a good deal of red cedar. There are also a few white pines on the western slope of this ridge. Along the highway from Warrenville to Meadville, at the edge of the Pequest meadows, there is some of the finest timber which was observed in this region, of chestnut, oak and hickory, from 10 to 30 inches in diameter and 50 to 60 feet high. One piece of about 50 acres near the head of the small swamp has been cut within two years. A good deal of the timber on the end of Cat mountain, west of Petersburgh, has been recently cut; what remains is from 8 to 16 inches in diameter and from 30 to 50 feet high, but it is scattering and mixed with small growth. At the head of the stream just northeast of Petersburgh there are a number of tamarack trees. Agriculturally this section about holds its own. There is not any important lapsing back of cultivated land into forest, and while the smaller houses are allowed to go into decay, the land continues to be farmed as before. It was noted that the end of the ridge extending westerly and sonthwesterly from Alamuche pond to Meadville is badly washed just north of the latter place near the small mill-pond. The bed rock seems to lie close to the surface and the soil washes off. Such land should be left in forest, as it must become less and less valuable for agricultural purposes.

The region above described constitutes the glaciated portion of that section of the Highlands which we described as the Alamuche-Pohatcong range in the physical description of the State, Vol. I., 1888.

Continuing westerly, we cross the Pequest meadows, which are not strictly a part of the Highlands but lie within the district. They contain much heavy timber, all deciduous, and of many varieties, but some of the best has been cut during the building of the Lehigh and Hudson River railroad, and since that time. On Mount Mohepinoke, west of Townsbury, less than half the area is forested. The timber varies from 2 to 14 inches in diameter and from 15 to 50 feet in height, being generally good timber and containing some large trees, from 14 to 24 inches in diameter, and 35 to 60 feet high. The undergrowth is quite thick, and there are red cedars near Townsbury on some abandoned pasture and stump land. Near Pequest mines some

large sumac was noted, 2 to 4 inches in diameter and 10 to 20 feet in height. On Jenny Jump mountain there has also been some recent cutting of timber about the old silver mine. The best growth is on the main ridge of the mountain, and it includes some hemlock. The timber on the foot of the hills, especially on the limestone, is inferior. A chestnut tree, 70 years old, measured 5 feet in diameter at the stump, but was rotten at the heart. About the foot of the mountain, in the valley, oak, chestnut, cedar, ash and poplar were observed. At Southtown some large sumac was noted, measuring from 2 to 6 inches in diameter and 10 to 25 feet in height. Just north of Shiloh, at the foot of the mountain, there is a locust grove covering about one and one-half acres, the origin of which was not ascertained. Southward from Shiloh chestnut and oak prevail, ranging from 2 to 16 inches in diameter and 10 to 45 feet in height, with some good timber near the Hope and Danville road. Southward from this highway, to where the road crosses to Green's pond, there has been much cutting within 15 years and the timber is now poor in quality. Just south of Kishpaugh mine a chestnut stump showed 100 rings, and measured 36 inches in diameter. One ring was observed measuring one-half inch in thickness. On the south end of Jenny Jump mountain the timber is quite good, ranging from 6 to 18 inches in diameter, and 25 to 50 feet in height. There has also been some cutting here within 15 years. At the outlet of Green's pond there is a tamarack swamp quite heavily timbered. Generally over this region of Jenny Jump mountain and Mount Mohepinoke the steeper slopes are wooded, but some of the gentler slopes have been cleared and are cultivated without suffering from wash. It is generally the fact that there is little or no evidence of wash where the Highlands ridges are deforested on the slope, although it is true that almost invariably the steeper slopes are well wooded. There is much more wash on the slate ridges, showing that it is largely due to the nature of the soil.

Mr. L. V. Williams, of Danville, speaking of this region, thinks that on an average timber is worth $20 per acre, and most of the mountains have a growth ranging from 12 to 18 inches in diameter, with chestnut predominating, but there is also a good deal of oak, especially rock oak, on the ridges. He thinks the tendency is for chestnut to increase and oak to grow scarcer, because the chestnut sprouts grow more rapidly and crowd out the oak. He considers the growth now much better than it was 30 years ago, as it is

allowed to stand longer before cutting. Good poplar is growing scarce. Each succeeding growth of chestnut appears to be thrifty. The growth is better on the south and east sides of the hills, although this is not so noticeable when the soil is good. On the Jenny Jump mountain district there seems to be a deterioration in the cleared lands, but elsewhere they are well kept up.

The timber in the Pequest valley, from Danville to Bridgeville, contains maple, elm, oak, hickory, and a little hemlock and spruce. Mr. Williams, before quoted, says that 15 years ago he cut off a piece of timber near Townsbury, consisting principally of oak, and since then nothing had grown there but red cedar.

The plateau bounded by Bearfort mountain, the New York line, Vernon valley, and the New York, Susquehanna and Western railroad, has about 80 per cent. of its area in timber, consisting mainly of oak and chestnut, a considerable portion of which is from 35 to 40 years old, and only a few acres older, the remainder being younger, ranging down to 5 or 10 years. The growth from 30 to 40 years old ranges from 6 to 10 inches in diameter, and from 35 to 45 feet in height. The more accessible portion of the timber is said to be cut at 20 years. Timber is believed to grow as rapidly as in earlier years. The only wastefulness apparent in cutting comes from the tendency to cut at too early an age, and this practice seems to be just about at the point of reform, owing to a change in demand for hoop-poles and cordwood, so that there is likelihood of future improvement. The swamp areas indicated on the topographical maps on this plateau are generally wooded with maple, beech, elm, and occasionally with scattered pines, larches and white cedar. A dense growth of rhododendron makes some of the swamps very dark and almost impenetrable. Forest fires sometime give trouble, and a large area east of Canistear, near Bearfort mountain, was burned over during this year. On this same plateau, southwest of the railroad at Stockholm, the condition of the timber is quite similar to what we have already described for the first two or three miles, but farther southwest the timber is older and larger. Chestnut is said to generally succeed all other growth, accompanied by a considerable percentage of oak. Pine is said to have been succeeded by oak and chestnut. The eastern slopes of the hills are thought to produce the best timber, especially near the foot, while the extreme tops also often produce good timber. This is attributed to greater depth of soil.

Pochuck mountain, lying just west of this plateau, does not differ from it materially, excepting that there is more hemlock and a somewhat thriftier growth. It is also not quite so densely wooded. Over the cleared portions the scattered growth is usually oak and chestnut, with some red cedar, maple, black walnut, &c. All these trees are of good size, the cedars from 8 to 12 inches in diameter and 40 feet high, and the other varieties from 12 to 24 inches in diameter and averaging about 45 feet high.

In noting large trees, here as elsewhere, no attempt was made to include them all, the purpose being rather to indicate about what could be seen in passing over the country, and the capacity of the soil to produce good timber. Four chestnuts were noted, ranging from 42 to 60 inches in diameter, and from 40 to 60 feet high, mostly near Stockholm and along the road to Vernon. The following oaks were also seen on Pochuck mountain: One, one-quarter mile west of Sand Hills, 48 inches in diameter and 60 feet high; another, one mile north, 36 inches by 60 feet, the spread of branches being 40 feet. In Vernon, there is one 42 inches in diameter by 50 feet high, and 3 miles north of Stockholm another oak was seen 30 inches in diameter by 45 feet high. An elm, one mile north of Stockholm, measured 30 inches by 50 feet, and another, northwest of Vernon, 30 inches by 60 feet. A maple was seen on Pochuck mountain 36 inches by 70 feet; two, east of McAfee, in the valley, about 30 inches by 50 feet; two, south of Vernon, about half way to Stockholm, about 48 inches in diameter by 50 and 60 feet high. Black walnuts were noted as follows: One, one-half mile east of Vernon, along the valley road, 36 inches by 50 feet, said to be one of the original forest trees. At McAfee, there is one 66 inches by 85 feet. On the side of the mountain, southeast of McAfee, there is an apple tree measuring 36 inches in diameter by 45 feet high, which is said to be the largest in Sussex county. Two miles southwest of Vernon, on the road to Stockholm, an oak and a walnut have grown together. At the base their combined diameters are 48 inches; above the junction each is about 24 inches in diameter.

The following was obtained as average values of timber near Stockholm: Stump land, $2; 20-years' growth, $7; 30-years' growth, $10; heavy chestnut or mixed oak and chestnut, $80. Heavy oak is said to be extremely scarce, but is quoted at from $60 to $100 per acre. At Vernon, stump land, $2; 20-years' growth, $7; 30-

years' growth, $12; heavy chestnut or mixed oak and chestnut, $80. There is said to be very little valuable pine. At McAfee, stump land, $3; 20 years' growth, $7; 30 years' growth, $10; heavy chestnut and oak, $75 to $80. At Canistear, stump land, $3; 20-years' growth, $10; 30-years' growth, $15; heavy chestnut, $60.

We shall next take up the balance of the glaciated portion of the central highland plateau which lies between Longwood and German valleys on the east, and the valleys of the Wallkill, Lubber's run and the Musconetcong on the west. Northeast of the Sparta turnpike, connecting Sparta and Dover, it is very generally forested, probably less than 10 per cent. of the whole being under cultivation. Along the western slope, between Hardistonville and Sparta, the growth is mixed, deciduous and coniferous, the latter being much the larger, from 10 to 20 inches in diameter and 40 feet high. On the top of the mountain, just east of Franklin Furnace, about Two Bridges, the growth is young, but little being even large enough for cord-wood, and very little as much as 30 years old. Thence along the top of the mountain to Ogden mines, the timber is mainly deciduous, and from general report, practically all of the timber has been cut once since the period of charcoal forges. About Ogden mines there is some older growth, but all the larger trees are cut out, the stumps averaging 40 years old, and a single one running as high as 53 years. Between Morris pond and the road to Ogden Mines the growth is from 2 to 6 inches in diameter and 15 to 20 feet high, and about 12 years old. Between Ogden Mines and Hopewell, down to the Sparta and Milton highway, we noted stumps which indicated the growth there to be from 34 to 40 years old. Generally it appeared to be from 4 to 8 inches in diameter and 20 to 30 feet high, but a few trees 16 inches in diameter and 50 feet high were noted. The growth is all deciduous. The north slope of Bowling Green mountain, and westward beyond the Ogden mines railroad, has a growth from 34 to 44 years old; one oak stump was noted 47 years old and 10 inches in diameter. On the top of the ridges hereabout the growth is from 2 to 8 inches in diameter and from 20 to 30 feet high, but where there is more soil the trees are from 4 to 14 inches in diameter and about 40 feet high. Between Morris pond and Hurdtown, west of the railroad, the timber is deciduous, with a few scattering pines, and it is generally small with some stump land, some 5 years' growth. The different tracts ranged from 2 to 5 inches in diameter and 20 feet high,

from 6 to 12 inches in diameter and 35 to 45 feet high, from 6 to 24 inches in diameter and 55 feet high, but trees 24 inches in diameter are very scarce. The best wood in this section is along the road from Woodport to Schofield mine, and is from 6 to 15 inches in diameter and 60 feet high, most of the trees being of the larger size, but the portion of this near the railroad is now being cut. The timber on the top of Bowling Green mountain is also good, from 6 to 14 inches in diameter and 40 to 55 feet high, the larger sizes predominating. This has also been cut in places. The west slope of Longwood valley was cut about 12 years ago; there are a few coniferous trees, spruces, pines and red cedar.

West of Woodport, between the head of Lake Hopatcong and the head of Lubber's run, the country is well wooded with oak and chestnut and scattering conifers. About Henderson cove, on the lake, there are scattering white pines and hemlocks. Excepting toward Bear ponds, where it is about 10 years old, the growth ranges from 6 to 24 inches in diameter and 30 to 60 feet high, most of the trees being from 8 to 14 inches, but occasionally one is found 36 inches in diameter. There is exceedingly little cleared land in this tract.

Between Lake Hopatcong and the valley of Lubber's run, from Byram cove to Stanhope, the country is almost entirely wooded. About Bear ponds there is much young growth from 6 to 15 years old, with better timber along the lake about Byram cove and Davis cove, ranging from 2 to 8 inches in diameter and from 20 to 35 feet high. From the River Styx to Brooklyn, it ranges from 6 to 14 inches in diameter, from 30 to 50 feet high and is entirely deciduous. Along the highway from Roseville to Stanhope reservoir, across the mountain, the timber is still better, while along the Musconetcong river, from Stanhope to Old Andover, it is large, ranging from 10 to 24 inches in diameter and 40 to 60 feet high, with quite a number of hemlocks. There seems to be a general absence of coniferous trees near Lake Hopatcong, but they are much more prevalent toward the valley of Lubber's run. It was noted that generally, throughout this western portion of the Highlands, there was very little evidence of bad effects from deforestation, even where the slopes are cleared and cultivated they do not seem to be inclined to wash as a rule. This is probably largely due to the nature of the soil. It was also noted that while many of the small buildings are allowed to go down,

the land cleared is as well cultivated as 15 years ago, when the topographical survey was made. There is practically no change in the location or extent of the forested areas. There was some exception to this state of things noted in the valley of Lubber's run, throughout which the farm lands seemed to be not so well cultivated, and showed signs of lapsing back into forest. Throughout the hill region chestnut and oak predominate, but in places there is a great deal of hickory. The better timber seems to sell at from $40 to $60 per acre.

Taking next the plateau east of Lake Hopatcong over to Longwood valley, we find, between Hurdtown and Lower Longwood, timber generally from 6 to 12 inches in diameter and 25 to 40 feet high, with some portions smaller. Near the Dover and Sparta turnpike the timber becomes somewhat better, ranging from 6 to 18 inches in diameter and 35 to 50 feet in height. On the end of the ridge east of Woodport, and near the lake, there are several white pines. Following down the turnpike toward Longwood valley, the growth becomes smaller again. Along the western slope of Longwood valley, from Lower Longwood toward Berkshire valley, a fire has extended about 1½ miles through young growth from 2 to 4 inches in diameter, all of which is dead. Further southwest, the timber ranges from 4 to 12 inches in diameter and 25 to 40 feet high. There is some coniferous growth, mainly spruce and hemlock. Continuing southwest from Berkshire valley, on the road to Davenport mine, it was noticed that some large oaks had been cut, ranging from 94 to 99 years old, and from 21 to 31 inches in diameter. From Davenport mine to Hopatcong, the timber ranges generally from 6 to 24 inches in diameter and 25 to 60 feet high. At one place all trees large enough for railroad ties had been taken out. Southwest of Lake Hopatcong branch of the Central railroad, over to the Delaware, Lackawanna and Western railroad, the timber is generally from 6 to 12 inches in diameter and 20 to 60 feet high, but there is some smaller growth only about 2 inches in diameter.

The age and diameter of a number of stumps in this region east of Lake Hopatcong were recorded, and become an index of the rate of growth of the timber. I give following, first the age, and then the diameter for different kinds of timber: Chestnut, 93 years, 32 inches; 89 years, 13 inches; 60 years, 14 inches; 43 years, 12 inches; 33 years, 9 inches. Oak, 99 years, 24 inches; 98 years, 31 inches

and 21 inches; 95 years, 24 inches; 94 years, 27 inches and 24 inches; 79 years, 14 inches; 78 years, 13 inches; 37 years, 9 inches; 33 years, 9, 11 and 14 inches; 32 years, 13½ inches; 30 years, 13 inches. Maple, 33 years, 14 inches. It was noted that several trees from 74 to 89 years old had apparently grown rapidly and uniformly until 30 years old, then very slowly for 10 years, but after that more rapidly again.

There is a general improvement in the cleared land and buildings in the neighborhood of the line of the Ogden Mine railroad. This is, no doubt, partly due to better railroad facilities since this railroad was connected with the Central railroad of New Jersey, and partly to the recent extensive operations at Ogden mine. Notwithstanding this improvement, however, little land has been cleared for cultivation, but the old clearings are better cultivated and cared for. Along the east shore of Lake Hopatcong there has been a considerable development as a summer resort, but this has not been attended by much clearing off of forests, the trees being preserved so far as possible.

From interviews with Mr. Titman, of Sparta, and others, it was learned that the greatest damage to forests in this vicinity comes from fires and cattle, the latter browsing off the young growth, or breaking it down. It is said that a fire which causes no great apparent damage at the time will cause the timber later on to decay at the heart. There seems to be very little wood in this district over 40 years old taken as a forest, although there are scattering trees very much older. As a rule the timber grows slower on the west and north slopes of the hills. The growth also varies with the character of the soil, and where the latter is very thin in certain instances a 40-years' growth has not attained sufficient size to be of any use, even for cordwood. Mr. Decker, who formerly ran a forge at Sparta, says that he shut his works down in 1865. He also says that when forges were running throughout this section, wood was often cut when 15 years old for coaling. Sprouts now come up quickly, and appear to be thrifty, but he thinks that if fires continue they will cause a deterioration in the forests. He also says that hemlock is usually left standing when the other timber is cut off, as it does not pay to get it out if at all inaccessible. This fact accounts for the larger size of most of the coniferous growth standing throughout this part of the State.

On Bearfort mountain timber has suffered much from fires. In

1882, during the prosecution of the topographic survey of that section, a fire ran over a large area south of the road from Greenwood lake to Wawayanda, and this fire did injury from which the forests have not yet recovered. A fire in 1891 ran over most of the mountain tops from the State line to Cedar lake. The timber is generally, both on account of these fires and the thinness or entire absence of soil over much of the mountain, scattering and of little value on the high ridges, but owing to its inaccessibility there has always remained a considerable amount of original forest, and in 1882 there was some quite heavy timber in the ravines, notably in the one heading at the westernmost of the two small ponds near the State line. This ravine was then heavily timbered, and travel through it was difficult, owing to fallen tree trunks. It was a good example of virgin forest. But, generally speaking, over the mountain tops the growth is scattering and inferior, which condition has been much aggravated by the recent fires referred to. There is a good deal of the common pine and some hemlock scattered over the mountain. The best timber is along the eastern slope, although this is all second growth; but the present growth is from 30 to 40 years, 8 to 10 inches in diameter, and 40 to 45 feet high. It is mainly oak and chestnut and scattering pine and hemlock.

Green Pond and Copperas mountains are mainly covered with a 40-years' growth of oak and chestnut, rather sparse and poor on the top and eastern face, where the soil is thin, but fairly good on the western slopes, being there generally from 8 to 12 inches in diameter and 35 to 45 feet high. As on Bearfort mountain there is a sprinkling of common pine. Some lots, aggregating perhaps 150 acres, have been cut off within from 10 to 15 years, but the remainder, if recently cut at all, has been only thinned out.

The west slope of Green Pond mountain has deciduous and coniferous trees in nearly equal amounts, consisting mainly of oak and chestnut from 4 to 10 inches in diameter and 30 feet high, or spruce and hemlock 6 to 12 inches in diameter and 50 feet high. The east side of the mountain has timber of the same general character, but more thrifty, while the flat top has a scattering growth of common pines, interspersed with scrub oak. It is noticeable that the coniferous growth disappears on this mountain, south of the highway from Middle Forge to Berkshire valley, and the deciduous growth begins, at from 4 to 14 inches in diameter and 20 to 45 feet high, deteriorat-

ing southwest, and ending in brush and scrub oak in the district north of Kenvil. Scrub oak prevails over the entire Bearfort and Green Pond mountain district, especially on the top of these ridges and on the sands which accompany this formation west of Clinton and on Succasunny plains.

The valley at Milton and Oak Ridge contains most of the cultivated land of this region, but about one-third of its area is in timber, mainly oak and chestnut of all ages from 15 to 60 years, with a little pine along the road south of Clinton, and some maple and other soft woods in the low grounds. It is noticeable that all the principal slopes about this valley, and generally on the upper Pequannock water-shed, are well timbered. The valley has a considerable number of scattered trees over its cultivated portion, mostly from 8 to 12 inches in diameter and 40 to 50 feet high. The large trees noted were a black walnut, three-quarters of a mile west of Milton, 30 inches by 50 feet; a red oak, one-quarter of a mile north of the same place, 36 inches by 40 feet, and another, near Upper Longwood, 60 inches by 60 feet. From Petersburg to Upper Longwood, along the road, there are from 20 to 30 oaks and maples, ranging from 12 to 24 inches in diameter and averaging 45 feet high. A maple east of Oak Ridge measures 36 inches in diameter by 50 feet high.

The portion of the Highlands lying between the valley running from Greenwood lake to Newfoundland, and Wanaque and Passaic valleys, was designated the Passaic range in the "Physical Description." A portion of this, north of Pequannock river, has 75 per cent. of its area in forest, the central belt of the range being almost unbroken by clearings. In the northern part there is a considerable amount of oak and chestnut, from 30 to 40 years old, including, perhaps, one-quarter of the whole region, while another large tract appears to exceed 45 years in age, all the more accessible portions near Wanaque valley and the Pequannock being young growth of all ages from 3 to 5 years and upward, with very little stump land and no new clearing. It is evident that the practice of cutting at 20 years or younger has prevailed for several years along the lower Pequannock, and it would appear that the forest has suffered injury in consequence. This young timber seems to have been mainly cut for charcoal, firewood, hoop-poles, &c. While the timber is mostly oak and chestnut, there is some pine and hemlock between Macopin and West Milford, also red cedar in old pastures, and some white cedar

south of Greenwood lake. The only portion of consequence which seems to have suffered from fire is an area of perhaps 150 acres along the Greenwood Lake railroad, just east of the lake. Most of the eastern part of this section is owned by Cooper & Hewitt, being a part of the Ringwood tract, and the forests of this part seem to be steadily improving. There is some new cutting about Hewitt, two or three hundred acres of stump and brush land being noted, and also some considerable areas of young growth of all ages.

Continuing along the Passaic range, southwesterly from the Pequannock river, to the moraine line at Danville and Dover, chestnut and oak still prevail, with some hickory, and many other kinds of timber distributed throughout. For the most part, it is from 30 to 40 years old, and some scattering parcels much younger between Charlottesburg and Marcella, and also between Bloomingdale and Brook valley. This younger portion is considerably mixed with cedar, white birch, &c. There is very little brush or stump land to be seen, and very little timber less than 10 years old. A tract of several thousand acres is now held as a private preserve about Stickle pond, and its forests are likely to be cared for.

The clearings in this district are almost entirely confined to the valleys of Green Pond brook, Beach Glen, Stony brook and the Rockaway river. The high lands are almost entirely covered with forest, the area of which amounts to some 75 per cent. of the whole district. The cleared portions are almost entirely grass lands. The population is decreasing, but there does not appear to be any considerable amount of cleared land which shows signs of lapsing back into forest. Between Rockaway and Mount Hope the timber is oak and chestnut ranging from 4 to 24 inches in diameter. Between Mount Hope, Hibernia and Denmark the timber ranges from 35 to 50 years old, and cutting appears to be more by culling out the best trees than by clearing off the entire tract, the smaller growth being preserved. West of Rockaway there is thrifty timber from 8 to 12 inches in diameter and 40 to 60 feet high, said to be about 60 years old. The timber continues to be excellent to and about Mount Pleasant mine. About Baker and Richards mines it is apparently as old, but the best has been culled out. Still, it continues to be fair on over to the valley of Green Pond brook. On the mountains, between Rockaway and Hibernia, the timber ranges from about 40 years old, near Beach Glen valley, to 60 years old further west. Some portions

have been recently cut, and some are from 10 to 20 years old. But generally the range is from 6 to 20 inches in diameter and from 30 to 60 feet in height. It is mainly oak and chestnut, with a few white pines and other conifers on the top and the more rocky slopes. Between Beach Glen and Meriden, it ranges from 12 to 34 inches in diameter and 50 to 60 feet in height, with a few coniferous trees as before. South and west of Split Rock, the oak and chestnut range from 7 to 35 inches in diameter and 30 to 45 feet in height. It is said that the last cutting about Split Rock for the use of the furnace was some 30 years ago. Further toward Marcella, oak and hickory were noted 10 inches in diameter and 55 feet high, while along the Marcella and Hibernia road the oldest timber is 45 years old, but there has been some recent cutting, and there are some tracts of younger timber.

From Beach Glen, eastward to the Morris canal, the country is best known by Mr. W. K. Clarke, of Rockaway. He says the last cutting for iron furnaces and forges in this district was done 40 years ago, although a trifling amount has been done since. He believes that after the forests here are cut two or three times more the growth will become stunted and worthless, and there will be a necessity for reseeding. He mentions a 10-acre tract on his property where, in 1838, his father raised a crop of buckwheat. It was then abandoned and oak and chestnut came up. The timber was cut off in 1866, the 10 acres yielding 200 cords of wood. In 1883 it was cut again, yielding from 12 to 15 cords per acre, and now, in 1895, the growth averages 4 inches in diameter and 25 feet high. He thinks the best growth is on the east and south slopes of the hills.

The district which we are describing has generally a growth of from 4 to 16 inches in diameter and 35 to 45 feet high. There are a few coniferous trees, principally white pine, the largest of which was 2 feet in diameter and 60 feet high, and about this tree there were a great many small pines, some 20 feet high, apparently sprung from the seed of the large tree.

North and northeast of Boonton, the mountains appear to have been cut off from 30 to 50 years ago, and are now beginning to yield good timber again. Some of the cleared land in this vicinity begins to grow up with red cedar. About Taylorville, it is said that the timber was cut about 30 years ago for the use of the forges. Mr. Ezekiel Earle, of Lyonsville, furnished the following interesting facts as to

this region: Last winter he cut a tract on the hill north of Dixon's pond, the timber of which was 60 years old and which yielded 50 cords per acre. He has some chestnut and oak timber which he has trimmed out and taken care of, and he believes it will yield one-third more wood per acre than other wood of the same kind and similarly located, which has been allowed to grow up in the usual way. His experience is that wood will usually yield one cord per acre for each year that it has been growing. He complains that the timber rots more at the heart now than formerly, and says this applies only to that which has sprouted up from the stump. The seedling trees are much thriftier and straighter than the sprouts. Just east of his home he has a tract of chestnut which has fine timber. The trees are about 45 years old, from 8 to 18 inches in diameter and 40 to 50 feet high. He says the seedling trees in this growth can be picked out with no difficulty. He says the continued cutting and lack of care is injuring the growth from the stump, and believes that the timber will deteriorate from this cause. He mentions a tract which was cut by his father, and which he believes was original forest. Since then it has been cut once more, about 20 years ago, and has never been more than brush since that cutting. He also stated that Andrew Cobb, who owned the forges at Split Rock, used to say that wood was most profitable for coaling when cut every 20 years. The opinion is general hereabout, as elsewhere in the northern part of the State, that the timber is better cut at from 30 to 35 years old than at 50 years, being sounder.

Mr. C. S. Dickerson, of Denville, who has much experience, furnishes the following facts: He is now cutting a tract of 100 acres, for which he paid $50 per acre, including timber and land, the timber being about 60 years old. So far as the young growth is concerned, he thinks it makes no difference whether timber is cut in February or August. He believes the forests in this section are now in better condition than they were 25 or 30 years ago, as they were then cut much younger, owing to the demand of forges, railroads, limekilns, &c., and later the hoop-pole industry. He says the second growth of timber is stronger, thriftier and thicker than the original, and each succeeding growth appears to improve. Timber ought to be cut at from 30 to 40 years old, as after that it begins to rot at the heart, and the older stumps do not send out as many or as thrifty sprouts as the younger. He says, also, that cordwood costs 60 cents to cut, $1.00 for cartage, $1.50 for

freight, and, allowing 15 cents for waste, this makes the total $3.25, whereas the market price ranges from $3.00 to $4.00 per cord.

Near Taylorville, some wood 12 years old was recently cut, and the larger trees were decayed at the heart. It is also stated that timber growing rather thin on the ground is better in quality than where it stands too close together, and that it should be trimmed out when about 3 years old, leaving the healthier sprouts to grow. The general trend of opinion seems to be that the rotting at the heart indicates the necessity of reseeding.

On this northeastern portion of the Highlands all of the steeper slopes are well forested, excepting a few which are rocky and will not support any growth. The cleared land is almost entirely confined to the bottom of the valleys, which are usually rather flat. The cleared portions are not highly cultivated, consisting largely of grass land. The water-sheds of the Ramapo, Wanaque, Pequannock and Rockaway lie almost entirely upon this glaciated Highland district, and to this fact is due their peculiar excellence as sources of water-supply for our cities. The foregoing description gives as good an idea of the forest conditions of these water-sheds as could be given by a separate description for each stream.

In Wanaque valley, although the timber is more interspersed with clearings, it does not differ from that already described, excepting that there is more red cedar, which is probably due to the fact that the land has been some time cleared.

Ramapo mountain is practically an unbroken forest, mainly oak and chestnut. The main ridge from Negro pond, south to the highway crossing from Midvale, is covered with a good growth of perhaps 30 to 40 years old, and most of the flatter portions of the mountain are likewise well timbered. Perhaps one-third to one-half of the slopes are not so well timbered, owing to thinness of soil. The southern end of the mountain is mostly covered with quite young timber and brush, and the timber on most of the more accessible parts has been cut within 20 years.

Generally, the Passaic range of the Highlands and Ramapo mountain are more lightly wooded, and the timber has been more severely cut during the last 20 years than on the Central Highland plateau westward. The proportion of forested area to the whole is about the same. In this part of the Highlands it is thought, generally, that the timber grows as vigorously as in former years, and it is asserted that

a 30 years' growth will yield as much wood per acre as the original forest. Some of the best timber here is on the slopes, but on the other hand more slopes have thin soil and there are more bare rock ledges than on the central plateau, and these have only a stunted growth or none, although they do not exceed probably one-third of the entire slope area. Flat hill-tops and ravines are well timbered as a rule, although some ridges are quite bare of soil on the top, and the forest is correspondingly poor.

The larger trees noted were two hemlocks, one mile southwest of West Milford, which measured 30 and 36 inches in diameter and about 60 feet high; a red oak at the same place measured 42 inches by 40 feet; an oak one mile north measured 54 inches by 70 feet, and another, one and one-quarter miles north, 42 inches by 45 feet, being a very beautiful tree. Near the same place we observed two chestnuts 42 inches in diameter and 40 and 60 feet high; a maple 42 inches by 80 feet; another, in a swamp, 48 inches by 70 feet; an elm 30 inches by 75 feet, with a beautiful spread of weeping branches. A chestnut near by measured 36 inches by 50 feet, and one at Midvale 54 inches by 50 feet; a pine at Wanaque measured 30 inches by 50 feet. No very large trees were observed on the high part of the Passaic range.

Not much reliable data could be had as to values. In the vicinity of Greenwood lake estimates ranged about as follows: Stump land, $5; 20-years' growth, $20; 30-years' growth, $30. At Midvale, stump land, $5; 20-years' growth, $10 to $20; 30-years' growth, $15 to $25; large oak and chestnut, $60 to $80 per acre.

We have noticed that a large amount of Highland forest ranges from 30 to 40 years old, and only a very small amount exceeds 45 years. All recent cutting also seems to have been of timber about 30 years old or younger. It would appear that much of the forest now standing, or which has been cut in recent years, dates from about 1850. Up to about that date there was a very large consumption of timber for charcoal to supply forges and furnaces, as well as for other kinds of fuel. Recently the cutting of timber less than 20 years old appears to have been somewhat checked. Most of this young timber was cut for charcoal, fuel and hoop-poles. The reason for this check is mainly to be found in the lessened demand or lower prices for these products. The evidence which we have collected seems to indicate that the best results are obtained by cutting at an age of 30 or 35

years. Chestnut, particularly, does not grow so thriftily after this age. A potent factor in checking this cutting of young timber is the tendency now prevailing to acquire large holdings of these northern Highlands. This movement is rapidly under way, and will undoubtedly result in a marked improvement in the condition of the forests during the next 20 years. At Wawayanda lake one owner holds 3,000 acres, and on Bearfort mountain an iron company holds 2,000 acres. At Cedar lake a club holds a large tract as a game preserve. At Ringwood the property of Cooper & Hewitt embraces a large extent of territory. At Stickle pond a private owner has acquired an extensive preserve. Thus private enterprise seems to promise the solution of the forest question in this portion of the State. As most of this land is entirely unfit for cultivation, and should always remain in forest in order to maintain the steady flow of the streams, as well as for other economic reasons, not to speak of the æsthetic, it is a matter for congratulation that such a movement has set in.

FORESTS OF THE SOUTHWESTERN HIGHLANDS.

The line of the terminal moraine, which subdivides the Highlands, crosses from Denville through Dover, Drakesville, the north end of Budd's lake, a point about one mile north of Hackettstown, through Townsbury to the Delaware at Belvidere. The unglaciated portion southwest of the moraine is, as we remarked, much better adapted to agriculture, so that generally speaking the Archæan plateaus and ridges have fully half their surfaces cleared and under cultivation, while the rather broad intervening valleys, which are on the slate and limestone, are almost entirely deforested and under a high state of cultivation.

Beginning at the northwest side as before, we have first the upper Pohatcong mountain lying between the Musconetcong and Pequest valleys. We have previously considered the glaciated portion northwest of the Hackettstown and Vienna highway. Southwestward the mountain is about half forested, the slopes especially being well covered, while the head of Pohatcong valley is deforested. The slope of the mountain, toward Musconetcong valley, is followed by the Morris canal, to which fact may be due the recent cutting which probably includes 60 per cent. of the timber, within 15 years, and

much of this has been cut within 5 years. The better growth standing ranges from 8 to 20 inches in diameter and 30 to 50 feet high. This larger growth prevails over the top of the mountain, where there has been much less cutting. On Furnace mountain, which includes the portion west of the head of Pohatcong valley, the timber ranges from 6 to 24 inches in diameter and 25 to 55 feet in height. Here, also, there has been some recent cutting. The timber is principally chestnut, with a good deal of oak, but we also find maple, birch, beech, poplar, ash, butternut, &c. There is no washing noticeable on the mountain slope, but there is some in Pohatcong valley, especially in the peach orchards and other areas which are not kept in grass or grain.

Just southwest is Scott's mountain, which includes some 40 square miles of plateau, surrounded by deforested valleys of slate and limestone. About one-half of the surface of the mountain is forested, including all the steeper slopes. North of the highway, from Oxford Furnace to Belvidere, the growth is deciduous; oak, chestnut and hickory, with the usual scattering birch, beech, maple, elm, poplar and ash. The best timber is from 8 to 24 inches in diameter and 30 to 55 feet in height, which includes about three-quarters of the whole, the remaining one-quarter having been cut within 10 years. There is a little hemlock near Oxford church. The southeast slope of Scott's mountain, which is also followed by the Morris canal, contains timber from 6 to 18 inches in diameter and 25 to 45 feet high, some of which has been cut within 15 years. On the western slope, toward the Delaware, there has also been some cutting, and in general the best timber is on the top of the plateau, ranging from 8 to 20 inches in diameter and 25 to 50 feet high, mainly of chestnut, oak and hickory, with the other varieties previously mentioned. There is a little cutting, but less than on the slopes. Such slopes as are cleared show no evidence of washing. The most accessible clearings are generally well cultivated. Those less easily reached show a few signs of deterioration.

The valley of the Delaware, westward, is almost entirely deforested, but the few scattered clumps of timber are good. The bluff along the river contains considerable hemlock.

The Pohatcong valley, eastward, including the broad stretch of level country at the south end of Scott's mountain, reaching over to the Delaware river, is entirely deforested, there being a lack even of

scattering trees, which makes this territory seem more bare than any other in Northern New Jersey. What little timber there is is confined to the bluff along the Delaware, and consists of a few larger trees from 10 to 13 inches in diameter and 30 to 45 feet in height, interspersed with a good deal of brush. We find here hickory, butternut, beech, oak, elm, birch and a little chestnut and hemlock.

Pohatcong mountain is a narrow ridge extending from Washington southwest to the Delaware river. It has some timber along its slopes, mainly oak, hickory and chestnut, with the other varieties which we have previously named interspersed, and also some clumps of common pine north of Asbury. The north end of the ridge has a medium growth from 4 to 6 inches in diameter, and some of the pasture is growing up to red cedar. A 50-acre lot was noticed on the northwest slope which has been cut within 7 years, and which shows almost no new growth since. The timber seems to have been principally oak. The timber is better as we proceed towards Bloomsbury, ranging from 10 to 30 inches in diameter and 30 to 55 feet in height, but the tracts are small. The best has been, or is now being cut. Just southwest of the Lehigh Valley railroad there is a piece of chestnut, oak and hickory which is better, ranging from 6 to 14 inches in diameter and 25 to 45 feet high. Thence to the Delaware it ranges from 8 to 24 inches in diameter and 30 to 50 feet high, but nearly all has been cut within 10 years, and the best of the remaining is now being cut out. On the ridge near Bloomsbury, oak stumps were noted as follows: 150 years old, 28 inches in diameter; 125 years old, from 21 to 29 inches, and 118 years, 25 inches.

The Musconetcong valley, southwestward from the crossing of the moraine, is generally deforested, but not quite so bare of timber as the Pohatcong valley previously described. The underlying rock of the valley is either slate or limestone, and its surface is highly cultivated. The slopes in the valley show considerable erosion from water, and it would seem that the steeper ones might well be reforested, but, as a whole, the country is too fertile to be kept in forest.

Schooley's mountain is crossed by the moraine from Drakesville by the north end of Budd's lake to a point about one mile north of Hackettstown, and this northern drift-covered portion presents a marked contrast to that south of the moraine. It is not only more generally forested but its clearings are neglected, buildings and

fences are falling down, and it is deteriorating into a wilderness, whereas, just southwest the clearings are in a high state of cultivation. The timber over this drift-covered area is generally from 6 to 12 inches in diameter, with some better, ranging from 8 to 24 inches in diameter and 30 to 55 feet high, but there is also a considerable proportion of small and inferior growth. There appears to have been a good deal of cutting done 10 or 15 years ago, but not so much recently. The timber is mainly chestnut and oak, but includes a wide range of other varieties. In the swamp west of Budd's lake there are a few tamaracks.

Southwest of the moraine line about 50 per cent. of the surface of the mountain, including the more level portions, is cleared and well cultivated. North of Drakestown the timber ranges from 6 to 16 inches in diameter and 30 to 50 feet high, and from Drakestown to Schooley's Mountain springs, from 6 to 24 inches in diameter and 20 to 55 feet high, but about half of this has been cut within 10 years, although there remains some very good timber. Around Mount Olive the growth varies from 8 to 20 inches in diameter and 30 to 55 feet in height, but there is some smaller growth interspersed. Along the east face of the mountain it runs from about 6 to 14 inches in diameter and 25 to 45 feet high, and there is a little cutting at present, while considerable has been cut from 5 to 10 years ago. There is not a great deal left here which is large enough for profitable cutting. Along the western slope, from Beattystown to Pennville, the timber is good, ranging from 6 to 16 inches in diameter and 30 to 55 feet high, some of which has been, and is now being cut. It is principally chestnut and oak, mixed with other deciduous trees. From Pennville to Changewater the growth is quite good, and about the same size as above, but from Changewater to Junction it is light, and ranges mostly from 6 to 18 inches in diameter and 30 to 45 feet in height, with a few larger trees. This slope of the mountain has washed considerable in places, and especially where there are peach orchards, the wash being much less when kept in grass. Taking this southern part of the mountain, from Schooley's Mountain post-office to the New Jersey Central railroad, the cutting within 5 years has been very severe, and all the heavier timber is being rapidly taken out. This is more the case than on any other part of the Highlands. Along the south branch of the Raritan all the old timber is cut, and when the lots now being cut are taken off there

will be nothing left but timber too young to be of any use. The farms in this section appear to be well kept up. Near Pleasant Grove an oak stump was noted showing 104 rings, which was 30 inches in diameter. The timber being cut on these southwestern Highlands at present is mostly worked up by steam mills into merchantable lumber of all kinds, including almost everything for which a ready sale can be found. Practically none of the area being now cut off is intended to be cultivated, but it will be allowed to grow up again in forest.

Musconetcong mountain is next, southwest. Along its western face, from Junction to West End, the average timber ranges from 4 to 8 inches in diameter and 25 to 45 feet high, of which a good deal has been cut within 10 years, and some quite recently. Some of this recent cutting seems to be followed by a poor and stunted growth, possibly due to the browsing of cattle. Around Pattenburg the chestnut and oak range from 6 to 10 inches in diameter and 30 to 50 feet high, and on the eastern slope, thence to the Central railroad, the timber is small. The best of this region is on the hills, near Glen Gardner. It is generally oak and chestnut, and other deciduous trees intermingled. The result of interviews in this region indicated that, in the first place, the timber was largely cut and coaled for the use of forges and furnaces, and then, after the Central railroad was built, there was a good demand for timber, and the forests were cut off, since which time there has been a lessened demand. The lots now being cut are those which escaped in the period following the completion of the Central railroad. It is said that chestnut grows faster than oak, although there was no complaint of deterioration of chestnut hereabout after reaching 30 years of age. There is no erosion of the slopes here, and the clearings appear to be well cultivated. Between the Lehigh Valley railroad and the road from Little York to Bloomsbury, the timber is mainly chestnut, oak and hickory, ranging, in different parts, from 4 to 8 inches in diameter and 20 to 30 feet in height, up to 18 inches in diameter and 30 to 50 feet in height. Quite a good deal has been recently cut, and a considerable area is brush. Along the Musconetcong valley slopes, above Warren paper mills, there are a few hemlocks; and on the same slope, near the West End mines, the timber ranges from 10 to 24 inches in diameter and 40 to 55 feet high. Further southwest the timber on this mountain varies a good deal, the different wood lots having been

cut at widely different periods. Near Gravel hill an oak stump was noted 100 years old and averaging 32 inches in diameter. Mr. D. Harrison, of Bloomsbury, mentions a lot of 20 acres on this mountain which was cut about 12 years ago and which has grown very little since, being now only 10 or 12 feet high, although all around it the growth is good. In general, the timber grows well and quickly. Chestnut usually comes up after cutting off, and he thinks the wood grows as well as ever it did, and that the wood is now better than it was formerly, that is, it is more durable. He mentions a young chestnut pole which was cut 80 years ago and has been in use ever since, being still well preserved.

On Succasunna plains we find a good deal of scrub oak, especially just northeast of Flanders, about the sand-pits and eastward of the Morris canal to the northeast of Kenville. This seems to be on a sand belonging to the Green Pond mountain rocks, and it is said that this scrub oak has been the same for a long time. It was noticed that where these scrub oak lands had been cleared they appeared to raise good crops. Generally, there is more timber over the plains than on the other valleys of this portion of the Highlands. Quite a good many white pines were noticed near Flanders, with some young pine, and a few hemlocks. Along the south side of the road from Flanders to Succasunna the timber ranges from 10 to 15 inches in diameter and 30 to 50 feet high. In some abandoned clearings common pine is coming up. There is some tamarack in the swamp south of Drakesville, and it is also found in the swamp on Black river from Horton Station to Succasunna.

German valley is generally deforested, especially from Naughright down to Califon.

On the long, narrow ridge at the southeast side of German valley, and running from Succasunna plains to Califon, there is a considerable amount of timber on the northwest slope, mainly chestnut and oak, ranging from 4 to 18 inches in diameter and 20 to 50 feet high, and it appears to be generally attached to farms and utilized in connection therewith.

Taking now the extension of the Passaic range southwest from Dover and Denville, we find generally about one-half of the country in timber, the greatest amount of cleared land being about Mendham and on the Upper Whippany, including Morris Plains. Along the west face of the plateau from Port Oram to Ironia, timber is from

6 to 12 inches in diameter and 30 to 45 feet high, while south of Port Oram, on the hill, it is good, but rather thin. Just south of Dover there has been some clearing near the town, but otherwise the hills are covered with a good growth, principally chestnut and oak, 6 to 16 inches in diameter and 30 to 40 feet high. Elsewhere in Randolph township it usually varies from 4 to 10 inches in diameter to from 6 to 16 inches, and there has been some recent cutting, but it is not extensive. The hills between Franklin and Rockaway are timbered with a growth 40 years old or younger. Some has lately been cut off, and probably one-half is less than 20 years old. West of Franklin, on the same ridge, it is from 6 to 10 inches in diameter, and 30 to 45 feet high, mostly oak and chestnut. The timber east of Den brook, over to Morris Plains, also appears to range up to about 45 years old, something near half being of this age, and the rest generally less than 20 years old. Oak and chestnut prevail. Near Camp Tabor several large trees have recently been cut, which had stood in the open with plenty of room. They were all 35 years old, measured from 24 to 34 inches across the stump and were from 40 to 50 feet high, sound at the heart. A case was mentioned here of a wood lot, the timber of which was from 40 to 50 years old, for which an offer had been made of $100 per acre. The trees between Shongum and Morris Plains, and, generally, in this vicinity, are about 44 years, all of which range from 6 to 24 inches in diameter and from 40 to 50 feet high. There are a very few coniferous trees; mostly in the valleys and along the streams. On Trowbridge mountain, northeast of Shongum, a few acres of timber were noted, measuring from 10 to 30 inches in diameter and 60 feet high. A few red cedars were noted near Morris Plains, and also some near Shongum. The timber near Morristown seems to be older and better than it is further west. Generally, from Morristown, Mendham and Chester, on the south, to Ironia and Mount Freedom, on the north, chestnut and oak predominate, either one or the other prevailing, but there is also a good deal of hickory, with some birch, white birch, maple, elm, &c. There does not appear to be much cutting at present, but there has been a good deal 10 or 15 years ago, so that there is much timber only from 2 to 5 inches in diameter, but it runs from these sizes up to 20 inches. A fair average of the timber would be from 6 to 10 inches and 30 to 45 feet high. The steeper slopes are generally forested, and there is no evidence of washing from deforestation. On

the easterly edge of the plateau, southwest from Morristown, the timber is of the same general character as that we have already described. As this is becoming a residence district there is a tendency to preserve the timber, and most of this is of fair size and age, and there is very little cutting. Further southwest, on Mine mountain, the growth is good and thrifty, ranging from 8 to 20 inches in diameter and 30 to 55 feet high. There is but little cutting, and, what there is, is mostly for fencing. It is mainly held either in connection with farms or the country places of people from the near-by cities, and there is a general tendency to cut the wood carefully and make the most of it. Over along the north branch of the Raritan there is some good timber, but most of it runs from 4 to 6 inches in diameter and 20 to 30 feet high. It is noticed that as we approach the red shale country there is generally more hickory and less chestnut. The region between Peapack and Chester has timber running from 6 to 14 inches in diameter and 30 to 50 feet high, but not much has been recently cut. A considerable amount was taken off between 10 and 15 years ago. There is good timber on Mount Paul, ranging from 6 to 12 inches in diameter and 25 to 45 feet high, and including about half a dozen white pines. Along the Black river, from Chester to Pottersville, the best timber has been or is now being cut, and the average growth is from 2 to 10 inches in diameter and 10 to 40 feet high. There are a few hemlocks near this stream.

Passing southwest, to the Fox hill district, we still note that chestnut disappears at the edge of the red shale, while the oak and hickory is good, but only small parcels are left standing, most of the country from the foot of the Highlands being cleared. There is also a good deal of cleared land on the plateau, about Fairmount and southwesterly, but the small lots of timber left standing are generally good, ranging from 7 to 16 inches in diameter and 30 to 45 feet high. Still further southwest, about Cokesburg and toward High Bridge, there are only scattering parcels of timber left, and here, as on the south end of Schooley's mountain, what remains is being rapidly cut off. The timber continues to be mainly chestnut and oak, with the usual sprinkling of other varieties, but here also, as elsewhere, the disappearance of chestnut, when we reach the red shale country, is very marked.

It will be noticed from the foregoing detailed review and description of the Highland forests, that the severest cutting at present is to

the southwest, where the proportion of forested area is the smallest. Further northeast, cutting is by no means severe, and the timber is steadily improving. It is also apparent that there is very little tendency to wastefulness, that the cutting of timber is determined entirely by the demand, and this is true not only as to the amount cut, but as to the age at which the timber is cut. In the past it was found profitable to cut timber for charcoal when 20 years old, and more recently for hoop-poles at a still earlier age, but, owing entirely to a change in the markets, this has all been altered, and the tendency at present is not to cut until the age of 30 years, or thereabout, has been reached. These facts, as to the history of the past, suggest at once that the same influences must determine how these forests shall be managed in the future. If there should come a demand which would make it profitable to cut at an earlier age than 30 years, it is difficult to see how such cutting can be prevented. It appears, however, that owners of the forest are ready for any suggestions which will enable them to derive a greater profit from their holdings, that they will not be slow to receive and take practical suggestions, or to improve on their present methods, and that a great deal can be done to aid the cause of forestry in this section of the State by instruction.

PASSAIC VALLEY.

This valley, lying between the trap ridges variously known as Watchung, or the First and Second mountains, and the eastern slope of the Highlands, is a portion of the red sandstone plain, and is all glaciated, excepting the portion lying southwest of the line of the Delaware, Lackawanna and Western railroad, between Summit and Morristown. This unglaciated portion, however, partakes to some extent of the character of the rest, rather than of the unglaciated portion of the red sandstone plain south of the trap ridges, both in the variety and the extent of its forest growth. This fact may possibly be due to the prevalence of gravel deposits traceable to Lake Passaic, which once occupied the whole valley, and partly due to a number of trap hills and ridges contained within the area, but whatever may be the cause, it is a fact that the whole valley may be classed together in relation to its forests. Generally, the percentage of forested area ranges from 20 to 40, averaging for the whole valley about 30 per cent. Pompton Plains is the most sparsely wooded section of the

valley. Over the northern part, generally, oak from 10 to 20 inches in diameter and 60 to 80 feet high is common enough to indicate that the soil is able to produce heavy timber, but the prevailing growth is quite irregular both in size and variety, and is generally smaller than that above noted. Softer woods, such as gum, maple, willow, &c., prevail on the flatter portions of the valley. There are also over the cultivated portions many scattering trees, planted forest trees, fruit trees, &c., many of which are of a large size, so that a general view of the valley from any commanding point gives the impression of a well wooded country. Riker Hill, Hook mountain, and the other trap ridges within the valley have timber resembling closely that of the Watchung mountain ridges, which we shall describe later. They are generally covered with cedar trees. The original growth was oak and hickory, and this was succeeded, when cut, by the red cedar to a great extent. On Hook mountain the timber of the east end was cut about 35 years ago, some parts a little later. Some is now being cut for fencing, &c., the trees running from 20 to 30 feet long, and cutting posts worth one and one-half cents per foot. A portion of the mountain near Tom's point was cut off from 8 to 20 years ago, and the growth is slow, consisting of oak, hickory, chestnut and whitewood, but little cedar, and it is generally true that there is little cedar all the way down on the east slope of the mountain, but on the west slope, wherever the oak and hickory is cut off, red cedar comes up abundantly. In one place the original forest had been cut off not over three years ago, and scarcely a sprout could be seen excepting red cedar. The oak and hickory is large, some of it apparently over 100 years old.

On Long Hill the timber is short and thin, with a good many red cedars, and a very little timber that would pay to cut. There is very little chestnut on this ridge.

Around Troy Hills and northward to Boonton, the larger timber is cut off for various uses, but the tracts being held in connection with farms are not cut off as a whole. Near Littleton some timber was sold 30 years ago for $60 per acre. Parsippany woods, east of Tabor, is about 40 years old, although a freshly-cut stump was noted 51 years old. The wood is light, 30 acres being recently sold for $20 per acre. Red cedars have come up here quite thickly, especially on former pasture lands. The wood is mainly oak and chestnut, and is all deciduous, excepting the red cedar. Along the road from Tabor

to Parsippany there are some oak and chestnut trees which appear to be from 100 to 150 years old. North of Lee meadows there is some timber said to be worth $75 per acre. The balance of the tract has had the large trees cut out, leaving mostly trees of about 30 years' growth.

On Horse hill, east of Morris Plains, the timber is from 4 to 7 inches in diameter and 20 to 35 feet high, on the south end, while on the top and east slope, it is from 10 to 20 inches in diameter, and toward the north end from 2 to 5 inches in diameter and 10 to 25 feet high, but here also there is some better timber, ranging from 6 to 24 inches in diameter and 25 to 45 feet high. The timber on this hill is mostly oak, with some chestnut, hickory and maple, and a good deal of red cedar about the clearings. About Malapardis, Whippany, Troy Hills and Parsippany much of the timber ranges from 6 to 18 inches in diameter and 25 to 50 feet high, but there is some 24 inches in diameter and 60 feet high. There appears to be no chestnut here, but mainly oak, hickory and maple, all looking thrifty, and there is very little cutting. There is also considerable red cedar hereabouts, and on the lower lands a good deal of pin-oak.

On the uplands, between Pine Brook and Swinefield Bridge, timber averages from 6 to 12 inches in diameter and 30 to 50 feet high, with very little chestnut, being principally oak and hickory. It looks thriftier on the uplands than on the meadows, the best of the timber being pin-oak. On the ridge between Whippany and Passaic rivers, from Hanover Neck to Madison, the timber seems thrifty, and ranges from 7 to 12 inches in diameter and 30 to 50 feet high, and seems to be carefully preserved by the owners. Between Whippany and Morristown, also, it is good, ranging from 6 to 12 inches in diameter and 30 to 55 feet high, but, for the most part, there is a little too much brush and young growth. There does not appear to be any chestnut, excepting along the banks of Whippany river, until we approach Morristown, and there is less red cedar than elsewhere. The timber is also quite good on the ridge near Convent, ranging from 6 to 24 inches in diameter, but there is considerable small growth mixed through it. There is a little chestnut between Hanover and Chatham, and the timber here is also thrifty, ranging from 4 to 24 inches in diameter, with most of the trees between 7 and 11 inches. South of Madison, on the ridge, timber ranges from 6 to 24 inches in diameter and from 30 to 60 feet

high, this being much larger than most of the timber in this neighborhood. The different kinds of oak predominate, but there is also some chestnut and hickory, with a few elms, maples, &c. On the upland, bordering the Great swamp, most of the oak appears to have been cut out within three years. There are quite a good many chestnuts and hickories. The larger trees left standing are from 6 to 11 inches in diameter and 25 to 40 feet high. There is, also, quite a good deal of brush and underbrush, with a good many young cedars. North of Green Village the timber is good, that is, what remains of it, but some has been cut within a few years. What remains runs from 6 to 10 inches in diameter and 30 to 45 feet high, with a few trees as much as 24 inches in diameter. It is principally oak and hickory, with some chestnut, maple, birch, &c. Northward of Green Village, and toward Morristown, timber is generally from 4 to 24 inches in diameter and from 20 to 50 feet in height, most trees ranging from 6 to 10 inches in diameter. The owner of a portable saw mill has just cut off a tract between Silver lake and Madison. On the southwest slope of the ridge, between Madison and Morristown, timber ranges from 6 to 11 inches in diameter and from 30 to 55 feet high, with some trees as much as 24 inches in diameter. It consists of oak, chestnut, hickory, maple, elm, birch, &c., with a good deal of cedar in places. Some of this timber has been trimmed out. In the neighborhood of New Vernon, the average timber ranges from 6 to 12 inches in diameter and 25 to 50 feet high. There are some pieces of young growth, and again there are tracts with trees 24 inches in diameter and 50 to 60 feet high. As a general thing there is little chestnut, excepting near the foot of the Highlands. Oak of all kinds predominates, especially white oak, and, on the flat places, pin-oak. We also find some maple, beach, elm, birch and white birch, with red cedar everywhere where old clearings have grown up. There has been very little cutting on this tract, between Morristown and the Great swamp, within the last 4 or 5 years.

On the northeast end of the Great swamp, near the edge of the uplands, there is a good deal of small growth, including red cedar. Further in the swamp the wood appears to be better, the larger trees ranging from 6 to 24 inches in diameter and 30 to 50 feet high. Larger sizes are not numerous, and a great many pin-oaks were noted. Along the edge of the swamp, next to Long Hill, a good many red cedars were found about the neglected clearings, and it also appears

to have succeeded the timber where it has been cut off. The timber in the swamp consists of oak, largely pin-oak, maple, birch and elm, with a few chestnuts, the latter growing only on the high ground. Taken as a whole, the timber in this swamp is very poor. One hundred acres in the southern part was cut off last year. The best timber is said to be near White Bridge, but good timber was also noted near the northeast end of the swamp, elsewhere the larger and better trees have been cut out. This cutting has been especially severe during the last 10 years. In the valley, along the river above Chatham, the most of the timber is either close to the stream or in widely-separated clumps, much of the valley being under cultivation. A good deal was noted ranging from 6 to 24 inches in diameter and from 30 to 50 feet in height, but some is smaller. Generally, this valley timber is thrifty and better than that on the adjoining ridges. The best of it is just west of New Providence. There is almost no chestnut here.

In the northern part of the valley it is estimated that swamp land timber of the older and heavier growth is worth, on an average, about $50 per acre, and upland timber of about the same age, $100 per acre, supposing, in each case, that the timber is mostly oak and hickory. It was claimed that stump land was worth from $20 to $40 per acre, but this estimate evidently does not consider swamp lands, which are generally worth less than this after the timber is cut off. Here, as in other portions of the State, the ordinary rule is followed to estimate for 30 years' growth a yield of 30 cords per acre, and thereafter about one cord per acre for each year that the timber has been growing. Observation seemed to indicate that most of the timber grows less rapidly after reaching about 30 years of age, and the largest yield is thought to be obtained by cutting it between 30 and 40 years old, especially if the growth is largely chestnut, as this timber often deteriorates as it grows older. There is some difference of opinion as to whether this deterioration is, or is not, increased by continual reproduction from the old stumps without reseeding, but the general trend of opinion is that this is at least increasing the tendency of chestnut to decay at the heart. If this is the cause it will be advisable to begin reseeding when timber is cut off.

WATCHUNG MOUNTAINS.

These two trap ridges have from 40 to 60 per cent. of their entire area covered with forest, the average being not far from 60 per cent. There is much more timber than on the Passaic valley to the westward, but the contrast is still sharper with the deforested country south and east.

North of Campgaw, there is an unbroken tract of about 2,000 acres of timber covering the trap hill. It is principally chestnut and oak, about 50 feet high and from 6 to 12 inches in diameter in the northern portion, and from 20 to 40 feet high and 3 to 8 inches in diameter in the southern part. From Campgaw, by Sicomac to the Goffle, the timbered areas are more scattering and also more varied in character, but oak and chestnut are still predominant. Over all these trap ridges red cedar prevails, springing up spontaneously and persistently in abandoned clearings. It is generally less than 20 feet in height. The Goffle has some good oak and chestnut timber 50 to 70 years old, from 50 to 70 feet high and 10 to 14 inches in diameter. On Preakness mountain, and the ridge just west, the growth is largely mixed with red cedar, and is of an inferior size and quality on the trap, being much better on the red sandstone portion of the eastern slope near the foot. Near Pompton lake there is considerable good hemlock, this last being a rather unusual growth for this part of the State. Second mountain, about Caldwell and northward, has some fair oak, chestnut and hickory. First mountain is not so well timbered, and has more red cedar. Abandoned clearings are quite frequent, and the whole of the growth is irregular and patchy. Most of the timber is also younger than that in the Hackensack valley. There is a noticeably greater prevalence of hickory on the trap than on the red sandstone.

Southwest from Caldwell and Verona the timber ranges, generally, from 4 to 12 inches in diameter and 20 to 45 feet high. There is very little chestnut, excepting near Montclair, on First mountain. On the same ridge, at Eagle Rock, the timber is small. Around St. Cloud the growth ranges all the way from 2 to 12 inches in diameter and from 10 to 45 feet high. On the east slope of First mountain, from West Orange to Wyoming, there is also much variation in the size. The west slope seems rather better wooded, ranging from 6 to

24 inches in diameter, with the larger part from 8 to 12 inches, and there is less young growth. On Second mountain, about Livingston, the timber is mostly oak and hickory, with very little chestnut. There is a good deal of small growth, but there are some trees ranging up to 24 inches in diameter. There is also much red cedar. Around Livingston there has been more clearing away of forests for cultivation than anywhere else noted. The timber on these ridges, here as elsewhere, continues to be inferior to that in the adjacent valleys. Near Northfield, a piece of timber was noted, about the best of any in the vicinity, ranging from 6 to 24 inches in diameter and 30 to 50 feet high. This lot contained 19 acres, and had just been sold, including land and wood, for $600. It was estimated that it would yield 28 cords per acre. Over this part of the mountain the timber ranges all the way from 2 inches up to 18 in diameter and from 10 to 45 feet high, with a large proportion of the smaller sizes, but some scattering trees are as much as 24 to 28 inches in diameter, the poorer timber being, generally, toward the top of the mountain and on the eastern slopes, but for two or three miles north of Millburn there is an exception to this rule, as the timber is good, and ranges from 6 to 24 inches in diameter. Around Short Hills and Summit there is a good deal of chestnut again, and not much cedar. Southerly from South Orange turnpike, First mountain and the valley west contains some pine. There is also a little hemlock along the Passaic near Stanley, and again near Millington. There is also a little pine on Long hill near Stanley, and on Second mountain, south of Murray Hill. Continuing southwest from Summit, the best timber continues to be on the west slope of the mountain. The various kinds of oak prevail, with chestnut, hickory and the other usual varieties. For the most part the wood is poor and appears to be stunted, although it is claimed that it can be profitably cut in 20 years, but our examination seemed to indicate that 40 years would be generally necessary, and even then the growth would be much inferior to that of the adjoining valleys. There is much of this timber ranging from 2 to 4 and 6 inches in diameter and 10 to 30 feet in height, with a little ranging up as high as 18 inches in diameter and 50 feet high. Continuing southwest of the road from Basking Ridge to Bound Brook, the timber becomes still poorer; the trees appear to be old, but are short and stunted. Continuing on around to Basking Ridge, the same conditions, generally, prevail, the wood being mostly

small, but with a few large trees. Throughout the whole extent of the ridges, red cedar appears to be abundant about the edges of the clearings, and where the clearings have grown up. Not much cutting was noted, as the growth was too small to make it profitable. The woods consist of oak, hickory, maple, birch and beech, with a little chestnut. We are inclined to think that the general inferiority of the timber of the trap ridges arises, partly, from the nature of the trap-rock soils, and partly from the fact that these ridges are very accessible to a thickly-settled country, where timber is comparatively scarce, and, in consequence, cutting has probably been more severe than elsewhere. As a result of these two causes the timber is deteriorating. On the whole, the tendency on these ridges seems to be to allow clearings to grow up, but as they have, within a few years, become occupied, to a great extent, by an immigrant population, this tendency may, possibly, be reversed, owing to different methods of farming. It may be mentioned, in this connection, that the curious fact has been noted, in our forest studies, that there is less disposition to destroy and waste the forests shown by our native rural population than by the immigrant population from countries where the control and management of forests is, on the whole, far superior to our own methods.

HACKENSACK VALLEY.

The Red Sandstone country lying between Palisades mountain on the east and Ramapo and Orange mountains on the west, was designated by us, the Hackensack valley, in the "Physical Description." Topographically, it is all one valley, although not all drained by the Hackensack river. It includes all of Bergen and Hudson counties, Passaic county, southeast of Paterson, and the northeastern corner of Essex county. It contains a large urban and suburban population, and it seems somewhat anomalous that it should also include some of the best timber of the State. The valley, as a whole, has 30 per cent. of its upland area in timber, or, in other words, 61,000 acres in a total of 180,000 acres of upland. Bergen county has 39 per cent. in timber, Hudson county only 5 per cent., the Passaic county portion 9 per cent., and the Essex county portion 20 per cent. In topographical position this timber is largely confined to the slopes, level valley bottoms and plateaus being mainly under cultivation. These cultivated portions, however, have a very liberal allowance of scattering

forest trees, orchards and other planted trees, so that in looking over the valley from an elevation it appears to be very generally wooded. The really forested portion ranges through all conditions, from a very limited amount of brush and stump land to heavy timber. Very little of it is now cut off entirely, most of the cutting being selected trees, so that the considerable amount of timber taken out each year is scarcely missed. There is no wastefulness apparent, as a rule, in the handling of the forests. It is generally a mixed deciduous growth, with oak predominating in the lower land along the Hackensack, while chestnut prevails on the higher ridges westward, and softer woods, such as gum, white birch, beech and maple in the swamps. Here and there are a few scattering hemlocks. From Closter to Englewood there is much red cedar. The timber is usually in rather small, isolated areas, not often reaching 100 acres in extent. There is a tract of some 500 acres along the Hackensack near the State line. Proceeding southward from the State line, across the whole width of the valley, there is a gradual decrease in the amount of timber. The growth in the vicinity of Ramseys to Wyckoff is rather mixed, consisting of oak, chestnut, maple, beech, elm, white birch, red cedar, &c., in all stages of growth, from brush to trees 80 feet in height, but there is a notable absence of stump land or new clearing. Near Paterson the country is quite deforested, the 9 per cent. of forest in the Passaic portion of the valley consisting mainly of small patches of oak and chestnut, preserved in connection with farms, and only cut occasionally and sparingly as needed. Most of the groves contain much fine timber, and are generally well cared for. Proceeding southwest into Essex county the wooded area is increased to 20 per cent. and is somewhat similar to that described, although the timber is, as a rule, not so good. There are some quite large timber areas north of Belleville. In this Hackensack valley, as a whole, the timber is probably as well cared for as in any other equally large section of the State. It is thrifty and healthy, and suffers comparatively little from fires.

The value of the land here is, of course, generally much too high for profitable forestry. In most well-located places it is worth from $400 to $1,000 per acre, where it is still sold by the acre instead of by the foot. In a few out-of-the-way places it ranges lower, but is in any case largely independent of the character of the timber. From inquiry, it was estimated, however, that the timber alone was worth

from $30 to $50 per acre for a 30-years' growth, and in proportion for younger timber, but old timber of mixed varieties is worth from $100 to $150 per acre. Swamp land timber is said to be rarely worth more than $20 per acre. In the vicinity of Wyckoff we obtained the following general prices: Swamp land, $5; 20-years' growth, $15 to $25; 30-years' growth, $25 to $35; large oak and chestnut, $75 to $100 per acre. About Oakland, stump land, $3; 20-years' growth, $20; 30-years' growth, $30; large mixed growth, $60. In such inquiries as this it becomes quite evident that many of the estimates given are based on the prevailing rule that timber will produce one cord of wood per acre for each year that it is growing, and that this wood is worth about $1 per cord on the stump, as was determined by a large number of written inquiries sent out by the Survey, the results of which were published in the Annual Report for 1885. This rule seems to prevail all over the State, but it is quite evident that it cannot be equally fair for all sections, although probably a good working average.

A few tracts claimed to be original forest were noted in the Hackensack valley. One is half a mile east of Hillsdale, containing about 30 acres of oak, 15 to 28 inches in diameter and about 70 feet high; a small piece of oak, one-half mile south of Riverdale, another, one mile west of Englewood, containing oak from 15 to 30 inches in diameter and from 60 to 80 feet high, and another piece of oak, one mile northwest of Oradell, on the ridge. It is noticeable that all of these tracts are of oak.

Several large trees were noted throughout the valley. At Hohokus, a fine elm 50 inches in diameter and 80 feet high, with a spread of branches of about 100 feet; one mile southwest of Etna, an oak 46 inches in diameter and 60 feet high; in an old clearing, one mile northeast of Saddle River, two chestnuts each 60 inches in diameter; on the estate of the late Hon. W. W. Phelps, at Teaneck, two oaks 40 inches in diameter; at Ridgewood, a chestnut 60 inches in diameter; at Haworth, a chestnut 84 inches and another 78 inches in diameter; north of Arcola, a chestnut 72 inches in diameter; at Overton, a chestnut 76 inches in diameter. Most of these chestnuts are only remarkable for girth, but near Oradell there is a fine chestnut tree 63 inches in diameter and 55 feet high; at the forks of the road, a little over one-half of a mile north of Ramseys, a chestnut 60 inches in diameter and 50 feet high; another, three-quarters of a

mile northwest, 60 inches in diameter and 45 feet high. Near Campgaw we noted a chestnut 62 inches in diameter and 60 feet high, and two others 66 inches in diameter and 50 and 60 feet high; north of Wyckoff, a large whitewood 36 inches in diameter and 80 feet high; near Wortendyke, a chestnut 48 inches in diameter and 65 feet high. Near Paterson chestnuts were noted 36 to 60 inches in diameter and 60 feet in height; also, two large black walnuts, near the river, northeast of Paterson, 42 inches in diameter and 60 feet high. The total consumption of saw-mills in this district was ascertained by inquiry to amount to practically 2,400,000 feet, board measure, of lumber, and besides this kindling-wood factories consumed the timber from about 25 acres annually. The whole consumption by these mills would, therefore, probably not exceed the growth from 85 acres annually. Besides this use, however, there is the consumption for railroad ties, telegraph and telephone poles and fuel, the amount of which has not yet been ascertained.

As regards the succession of growth, the general opinion seems to be that it is of the same kind as that cut off, although some claim that white oak and hickory are followed by a more mixed growth. It is evident that since the cutting off entire of areas of timber seems to have been long ago abandoned in this vicinity, and that most of the cutting is, as we have remarked, by culling out, there cannot be much reliable data obtained on this point. At Moonachie, maple is said to have succeeded oak, and at other places the succession has been chestnut. There is no room for doubt, however, that as a rule abandoned clearings grow up in red cedar, although this is occasionally accompanied by, or replaced with, white birch.

Groves of planted white pine may be seen on the estate of the late William Walter Phelps, and also one mile east of Saddle River, south of the road from Ridgewood to New Milford.

PALISADES MOUNTAIN.

It will be a surprise to many to learn that this ridge, so near to the large cities and in the most populous section of the State, is so well wooded. From the State line, south to Edgewater, a distance of 13 miles, and for a width of 1½ miles back from the bank of the Hudson, practically 90 per cent. of the whole area is well timbered. The forest covers an unbroken tract of 11,000 acres. Beginning at the

State line and extending to 1 mile below Huyler's landing, we have, on the talus slope along the river, a mixed deciduous growth, mainly chestnut and oak, from 30 to 60 feet high, varied with pine and hemlock near Huyler's landing. We give here, as elsewhere, only the prevailing timber, but in reality this whole Palisades forest includes a large number of varieties. Further down, to Linwood, the growth on the talus is more irregular, containing a fair proportion of oak and chestnut of good size, with scattering hemlock. From Linwood to Fort Lee the talus is well wooded, some good white pine being found, but oak and chestnut prevail. From Fort Lee to Edgewater the river slope of the ridge is well timbered, but a strip of land along the river, at the foot, has been cleared and occupied by residences. On the flat top and upper portion of the western slope of the mountain, from the State line to Edgewater, if we except some red cedar near the State line, the growth is practically of mixed deciduous varieties, mostly oak and chestnut. This timber ranges from undergrowth to trees 40, 60 and 80 feet in height. Diameters of from 20 to 30 inches, and heights of from 60 to 80 feet, are not at all uncommon, especially from Huyler's landing to Edgewater. Taken as a whole, there are not many finer belts of timber in the State. The land is largely held in such a way that there is comparatively little danger of wholesale deforesting, but this beautiful forest has almost as good a claim to future preservation as the escarpment of the Palisades. South of Edgewater the ridge is practically a city to Bergen Point, and entirely deforested.

FOREST COVER ON THE SLOPES.

On the southeastern part of the Highlands we find steeper slopes, very generally wooded, and a detailed examination of such slopes as would be likely to wash, because of lack of forest cover, shows that not more than 5 per cent. of their area has been cleared of timber. There is, to be sure, also a small proportion of rocky slope which does not bear timber, because the soil is lacking, and which never has been able to support the growth of forest. As we have remarked, in dealing with this section, the clearings are almost entirely confined to the valley bottoms and a few level places on the plateaus. Over the southwestern Highlands we find more slopes deforested, as should be expected, as a larger percentage of the whole area is under cultivation.

We find here that 30 per cent., or about one-third, of the steeper slopes have been cleared. There is no evidence of serious wash due to this clearing on the Highlands proper, excepting a little along the Musconetcong valley, where the slopes are in peach orchards. These orchards, being kept cultivated, with no cover of grass or grain, are peculiarly liable to wash. Some of the slopes in the deforested and highly cultivated valleys, where the underlying rock is slate or limestone, also show considerable erosion due to wash, and here, if anywhere in this section, some attention might profitably be given to reforesting the steeper slopes, although, as a rule, the land is too fertile and productive to be allowed to remain in forest. On the red sandstone plain, northeast of the moraine, we find 53 per cent. of the steeper slopes stripped of forest, but it must be remembered that here the country is much more level, as a whole, than in the Highlands, and while there the slopes cover a large proportion of the whole area, they are here comparatively insignificant in area. What forest there is on the red sandstone is rather more likely to be on level areas than on slopes, as it is left standing where the soil is wet and cold, or where it is largely covered with boulders and drift, so as to be untillable.

FOREST CONSIDERED BY WATER-SHEDS.

The most important Highlands water-sheds are the headwaters of the Passaic, and those who would know in detail the condition of the forests on these streams should refer to the description of the southeastern Highlands, already given in this report. The Rockaway, at Boonton, has 82 per cent. of its catchment in forest, while the Pequannock has 78 per cent., and the Wanaque and Ramapo each about 75 per cent., including the portion in the State of New York. These four streams are all in the northeastern Highlands. On the southwestern Highlands we have only the Whippany, above Morristown, which has 55 per cent. of forest. The upper Passaic, at Chatham, lies largely in the central Passaic valley and the red sandstone plain. It has 23 per cent. of its catchment in forest. The Passaic, as a whole, has a catchment of 949 square miles, of which 508 square miles lies on the Highlands, and 441 square miles on the red sandstone. Forty-four per cent. of the whole catchment is forested, but about 59 per cent. of the portion above Paterson. The Raritan

headwaters also lie on the southwestern Highlands, and have about 30 per cent. of their catchment in forest, while the Musconetcong, in this same region, has 39 per cent. in forest.

Here in the Highlands, as elsewhere to a great extent in the State, the principal importance to be attached to the proportion of forest on the water-shed is that it is indicative of absence of cultivation, and to a certain extent, of population, consequently there is less roiliness of the water, and less liability to pollution where the per cent. of forest is large. While, as a whole, the Highlands streams are of good quality in their natural condition, and good potable waters, it is nevertheless plainly evident that those streams which have their catchment in the northeastern glaciated Highlands carry much less sediment, and are purer and clearer than those in the more highly cultivated southwestern Highlands. This fact we believe to be due partly to the larger percentage of forest and less extent of cultivated lands which we have noted. The Pequest catchment also lies to a considerable extent on the southwestern Highlands, but has so much of its area in the Kittatinny valley that the forested portion is only 18 per cent. of the whole.

On the red sandstone the Hackensack catchment has about 60 per cent. of forest area, and we believe that it is at least partly due to this fact that the Hackensack carries much less sediment than streams like the Raritan, on the deforested portion of the red sandstone.

RELATION OF FOREST TO THE FLOW OF STREAMS.

In connection with our studies of the water-supply of the State, we have, since 1890, made extended observations of the flow of our streams. We also studied a large number of measurements of the run-off of streams over the United States. Incidentally some attention was given to the question of the relation borne by forests to stream flow, but this being merely incidental, it is our purpose at present to give a fuller account of these studies and supplement them by some further examination.

The question of the effect of cutting of forests had been brought to our attention by the widespread opinion held by the people of the State that the streams had been unfavorably affected by the cutting off of forests, and believing that widespread popular opinion usually is founded on some fact, we were led some years ago to give some at-

tention to the matter. The grounds most frequently stated for the belief that the streams had fallen to a lower stage than formerly appeared to be that certain streams, like the Rancocas and other branches of the lower Delaware, the Raritan, &c., had formerly been navigated to a considerable extent, and it is popularly believed that this would be impossible at present. It was also claimed that the streams run much lower than formerly and are more subject to serious floods. I have found that these opinions are shared alike by the ordinary and the more scientific observers familiar with the streams of the State. It was also found that the extremely dry years of 1880 and 1881 led to a widespread expression of these opinions, and the cause assigned to the falling off of streams was almost invariably the cutting off of forests. The assignment of this cause appeared to be, to a considerable extent, due to the suggestion of writers on forestry and advocates of forest protection. The aim of our studies has been to ascertain what definite data and actual measurements show as to the truth of these assertions.

Before proceeding very far we were confronted with lack of evidence that the amount of land in forest has sensibly decreased within the State during the last half century. In general, the land not actually cultivated in the State is forested, excepting about 10 per cent., which represents fallow land, highways, town sites, &c., consequently we will take the statement of the number of acres in farms, and of the portion of that land improved, from the United States Census, since 1850, in order to ascertain whether there has been any considerable change in the amount of forested land:

	1850.	1860.	1870.	1880.	1890.
Total land in farms.....	2,752,946	2,983,525	2,989,511	2,929,773	2,662,009
Improved land in farms.....	1,767,991	1,942,281	1,978,067	2,097,719	1,999,117

It will be seen that the improved, or cultivated, land is increased only to the extent of about 231,000 acres since 1850. As the total upland area of the State is 4,500,000 acres, it will be seen that this is but 5 per cent. of the upland area, and it will also be noticed that the total land in farms has actually decreased. Since 1860 the amount of improved land has increased by an amount which is equal to only about 1 per cent. of the entire area. Robert Gordon made an estimate, which indicates that 76 per cent. of the entire area was in farms in 1833. This was, probably, rather high, but still the in-

dications are that there has been no important increase of cultivated land for over 50 years, consequently, any change which may have been noted in the streams, in the memory of people now living, is not likely to have been due to a decrease in forest area.

The question which suggests itself next is whether the character of the forest has changed. We have a large amount of evidence to the effect that when the forges were running, all over the State, the cutting of forests was very severe, in order to procure coal for the forges and fuel for other purposes; as before the general introduction of anthracite coal, and, indeed, for a good many years after, the use of wood for domestic purposes and in many industries was much more common than it is at present. The Highlands forests were then generally cut at the age of about 20 years, and we find at present a very large amount of Highlands forest which dates from about 1850, consequently, it would seem to be indicated that the forests in that section of the State, at least, are now older and heavier than they were in 1850, when, it is said, large areas of the Highlands presented an extremely bare appearance. Nevertheless, it is quite possible that, on the whole, a considerable amount of heavy timber throughout the State has disappeared since that date, and been replaced by a younger growth. This is, perhaps, true to a greater extent on the portions of the Delaware water-shed which lie outside of New Jersey than on any of the water-sheds of this State.

We have also to remember, in considering the early navigation of our streams, that this was usually in flatboats, drawing very little water, and it is true that for considerable portions of the year these streams could still be navigated in this way, where no artificial obstructions have been introduced. When they were navigated there were no railroads, and the highways were in very poor condition; consequently, facilities for transportation by water, which would now seem ridiculously inadequate, were then adopted as the best means at hand. We shall see, as we proceed, nevertheless, that there may be some ground for the popular opinion that the streams are, much of the time, lower than they formerly were.

We will proceed to examine the large amount of data as to stream flow which we have at hand, in order to see what may be discovered as to the effect of forests from this. Much of the data which we shall refer to has been given in the Report on Water-Supply of 1894. First, the examination of the longest and best rainfall records shows

a tendency to gradual increase in the rainfall of the State from 1825 up to about 1870, since which time we have passed through some remarkably dry periods and the rainfall has fluctuated. The severest of these dry periods extended from about 1875 to 1886, and a number of years from 1875 up to the present date have had severe droughts, although we have also had, during that period, some extremely heavy rainfalls for certain years. These changes in rainfall, which are probably not permanent, may have a considerable bearing upon the alleged falling off in the flow of the streams.

The next important matter to be investigated is whether our recorded stream flows indicate any effect of forests upon evaporation from the surfaces of the water-sheds. There have been a good many claims, apparently well-grounded, that forests diminish this evaporation as compared with cultivated areas. One class of data on which this is based, however, must be rejected. We refer to experimental measurements of evaporations from the soil within the forest. Such experiments cannot even approximate the conditions which exist in nature, and moreover, our problem must include all of the evaporation; that is, not merely the water which is evaporated direct from the soil, but that which is taken up into the trees, either to be again exhaled to the atmosphere, or permanently incorporated in the substance of the tree.

We can conceive of no way which will so accurately measure the evaporation from a given area of the earth's surface as to measure for a series of years the total rainfall upon that area, and simultaneously, the total amount of water which runs off in the streams. We have found that only an insignificant amount of water is taken permanently into the ground on ordinary water-sheds, so that the difference between the total rainfall and the total run-off represents direct evaporation by the atmosphere, together with the water taken up by vegetation to be either ultimately evaporated into the atmosphere or incorporated into the plant. There may be difficulties in making such measurements, it is true, but they are nowhere near so great as the difficulties in the way of more limited experiments, for we, in this way, preserve natural conditions; moreover, it has been found possible to make these measurements sufficiently accurate for all economic purposes, and any influence which forests may have upon evaporation which cannot be detected in this way is too unimportant to have any economic bearing. Therefore, if we have a

large number of good gaugings for water-sheds, varying considerably in the proportion of forest area, or otherwise in the character of their vegetation, we ought to be able to discover in this way whether this vegetation has any important influence on evaporation.

In the Report on Water-Supply we investigated, in this way, records of rainfall and flow-off on eight streams in the eastern United States, the length of the records varying from 7 to 17 years. Our investigations led us to the discovery that the important factor in determining the amount of evaporation was the average temperature for the water-shed, and we found that evaporation increased or decreased through the range of our observations at the rate of 5 per cent. for each increase or decrease of one degree in mean temperature. We tested this law by applying it to the 8 streams of the eastern United States, and to 6 streams in the Mississippi valley, and found that it held good for temperatures from 47 to 60 degrees. We then applied the law to gaugings of 12 New Jersey streams, and found that it held good for these also. It is evident, therefore, that we can make no correct comparison of evaporation from forested and deforested water-sheds without allowing for difference in temperature, and, indeed, without such allowance we shall find that in many cases forested water-sheds show a much larger evaporation than those almost entirely deforested. For instance, the evaporation on our Raritan water-shed, which has only 13 per cent. of its area in forest, is more than 10 per cent. less than on the Great Egg Harbor, which has 88 per cent. of its area in forest. In the table accompanying, I have used some data which are fuller and better than I had at the time that the Report on Water-Supply was written, but for the most part they are taken from that report. The table shows the mean temperature of each water-shed, the per cent. of its area in forest, the ratio which the observed evaporation from that water-shed bears to the observed evaporation of our own Passaic water-shed, the latter being taken as 100, and in the last column the same ratio as determined from the mean temperature by the previously referred to law of increase and decrease, and I may here remark, that this law of increase and decrease is one which has long been an established law of physics, although it has never been applied to evaporation from the surface of the earth, so far as is known to us, until it was so applied in the Report on Water-Supply.

COMPARATIVE TABLE OF EVAPORATION FROM WATER-SHEDS.
EVAPORATION FROM PASSAIC WATER-SHED = 100.

	Temperature. Degrees.	Per cent. of forest area.	Observed ratio of evaporation to that of Passaic catchment.	Ratio to Passaic catchment, computed from temperature.	No. of years of record.
Passaic	49.7°	58	100	100	17
Ramapo	48.5°	75	103	94	2
Pequannock	47.4°	78	87	88	3
Musconetcong	48.4°	39	92	93	2
Pequest	48.4°	18	91	93	2
Paulins Kill	48.4°	27	97	93	2½
Hackensack	50.6°	60	104	104	8
Raritan	50.6°	13	104	104	4
Delaware	47.4°	53	82	88	1
Great Egg Harbor	52.5°	88	120	114	3
Batsto	52.5°	88	115	114	1½
IN OTHER STATES.					
Sudbury, Mass	49.7°	14	100	100	16
Croton, N. Y.	49.7°	30	100	100	14
Connecticut	47.0°	53	86*	86	13
Neshaminy, Pa.	51.7°	7	107	110	7
Perkiomen, Pa	50.7°	25	105	105	7
Potomac	52.0°	52	109*	111	6

We have, however, to allow for the fact that evaporation varies somewhat with rainfall, although not in direct proportion thereto. The relation was carefully determined for the Passaic in the Report on Water-Supply, and is expressed by the following formula relating to yearly rainfall and evaporation, all expressed in inches:

$$\text{Evaporation} = 15.5 + .16 \text{ rainfall.}$$

In order to compare the evaporation on a given stream with that of the Passaic, as in the table, we ascertain the average rainfall, and deduct from it the average run-off for the stream in question, taking the difference as evaporation, and then computing what would have been the evaporation on the Passaic for the same average annual rainfall by means of the above formula. The two columns of the table showing the ratio of evaporation as actually observed, and as it

* From gaugings published by Cyrus C. Babb, in Transactions of American Society of Civil Engineers, being longer and fuller than those given in the Report on Water-Supply.

should be when the difference of temperature is allowed for, may be compared to determine the effect which a larger or smaller percentage of forest area may have upon the evaporation from the given water-shed. If the observed ratio is larger than the computed, it will indicate greater evaporation, and if it is smaller it will indicate less evaporation. It will be seen that, as a whole, the agreement is remarkably close, and especially so with the longer series of gaugings, the length of the record being shown in the last column. The table fails, absolutely, to indicate any effect upon the evaporation due to such forests as prevail over the Eastern United States. It should be said that, where we have no other data, the per cent. of forest area is computed by taking the difference between the total area and the area of improved land, as given in the census, and then deducting from this 10 per cent., which we have found to be the proper amount to represent highways, town sites and fallow lands. In New Jersey, forest areas are measured by actual survey. It will be noted that the range of forested area is from 7 to 88 per cent. of the whole catchment.

We may now turn to some facts which are matters of general observation, and see how these support this conclusion. If forests require so much less water than cultivated areas or grass lands it would seem to follow that they should be found flourishing where the rainfall is too light to support other vegetation, but, taking the country as a whole, this is by no means true. It has been generally observed that, for a temperature of about 50 degrees, like that of our own State, forests cease to be abundant when rainfall becomes less than 32 inches per annum, and practically disappear when the rainfall becomes as low as 26 inches. It has also been observed that less than 20 inches of rainfall is accompanied by an exclusively pastoral country, and that at 14 inches vegetation practically disappears. These facts do not seem to indicate that forests thrive with less moisture than other vegetation. It will also be noted that in both cases the difference between abundant forest and no forest, or fair vegetation and no vegetation, is 6 inches of rainfall, and this 6 inches of rainfall is exactly the amount which we determined in our Water-Supply Report to be needed by vegetation alone on the Passaic water-shed, where, during an average year, the rainfall is 45 inches, and the total evaporation 22.7 inches, including the 6 inches allowed for vegetation. We also know that in 1881, a very dry year, when the rain-

fall fell to about 32 inches in Northern New Jersey, the spring and summer rainfall together amounting to 15.70, our forests began to die on the tops of the mountains, and again in 1894, the spring and summer rainfall amounting to 15.67, the forests turned brown over the Highlands and began to perish. In Kansas the limit of abundant forest is, as we have noted, at about 32 inches annual rainfall; and it would appear, therefore, that our own forests would begin to die out if our rainfall should sink as low as this limit; consequently, the evidence is that 32 inches of rainfall annually is necessary to support healthful forests at this temperature. This seems sufficient evidence that there cannot be less loss of water from forested areas than from cultivated.

We shall next investigate the influence of forests upon the greatest floods and the lowest dry-season flow of streams. We have prepared a table showing, in connection with the percentage of forested area, the rate of greatest and least flow for our own streams and others in the Eastern United States. As the greatest flow is always at a less rate in proportion to the drainage area on large streams than on small

RELATION OF FOREST AREA TO GREATEST AND LEAST RATE OF FLOW OF STREAMS.

CATCHMENTS LESS THAN 200 SQUARE MILES.

	Catchments in square miles.	Per cent. of area in forest.	Flood flow in cu. ft. per second per sq. mile.	Lowest flow in cu. ft. per second per sq. mile.
Sudbury, Mass.	78	14	41.4	0.036
Croton, West Branch, N. Y.	20	56	54.4	0.020
Ramapo, N. J.	160	75	66.1	0.140
Wanaque, N. J.	101	75	48.9	.....
Pequannock, N. J.	85	78	52.7	0.130
Rockaway, N. J.	119	82	40.7	.....
Musconetcong, N. J.	156	39	12.8	.....
Musconetcong, N. J.	68	85	15.9	.....
Paulins Kill, N. J.	175	27	23.0	0.130
Swartswood Lake, N. J.	16	22	65.8	.....
Pequest, N. J.	158	18	12.5	.....
Pequest, N. J.	83	18	9.6	0.170
Pequest, N. J.	35	18	18.7	.....
Pequest, N. J.	2	...	25.3	.....
Tohickon, Pa.	102	28	54.3	0.001
Neshaminy, Pa.	139	7.	41.4	0.009
Perkiomen, Pa.	152	25	34.9	0.050
Hackensack, N. J.	115	60	.....	0.190

CATCHMENTS 200 TO 2,000 SQUARE MILES.

	Catchments in square miles.	Per cent. of area in forest.	Flood flow in cu. ft. per second per sq. mile.	Lowest flow in cu. ft. per second per sq. mile.
Concord, Mass.	361	...	12.3	0.17
Charles, Mass.	215	...	.....	0.20
Housatonic, Ct.	790	...	.....	0.17
Croton, N. Y.	339	30	74.9	0.15
Passaic, N. J.	797	59	24.2	0.19
Passaic, N. J.	822	58	22.2	0.19
Raritan, N. J.	879	13	59.3	0.14
Great Egg Harbor, N. J.	216	88	22.0	0.27
Schuylkill, Pa.	1,800	...	.....	0.17
Potomac, Md.	920	52	19.5	0.02
Greenbrier, Va.	870	...	.....	0.12
Shenandoah, Va.	770	...	.....	0.17
Neuse, N. C.	1,000	...	.....	0 19

CATCHMENTS OVER 2,000 SQUARE MILES.

Merrimack, Mass.	4,599	...	20.9	0.31
Connecticut, Ct.	10,234	53	20.3	0.31
Delaware, N. J.	6,790	53	37.5	0.17
Ohio, Pa.	19,900	...	.....	0.11
Potomac, Va.	4,610	52	22.2	0.08
Kanawha, Va.	8,900	...	13.5	0.12
James, Va.	6,800	...	.....	0.19

ones, while the dry-season flow is usually proportionately larger, it is improper to compare very large water-sheds with very small ones, therefore, we have grouped the streams according to the size of their drainage areas. This table shows the comparative violence of floods and lowness of dry-season flow in the last two columns. No relation is apparent between the proportionate forest area and either the greatest or least flow, and it is evident that these are both controlled by other conditions. In the case of floods, the controlling influence is topography, and in the case of dry-season flow it is the surface geology, that is, the character of the soil and sub-soil. All notes which we have of the severest floods show that they have occurred in such exceptional conditions as warm rains falling on a heavy accumulation of snow, or from heavy rains on frozen ground, or, in summer exceptionally heavy rains on ground already saturated with water. It ought to be apparent that forests cannot effect such conditions as these to any great extent.

The lowest flow occurs after the streams have been, for a long time, drawing upon their springs, and have extracted the water from the ground to a considerable depth below the surface. Our investigations show that such flow is usually reached in our State when the water has been drained from the sub-soil to an average depth of over 4 feet. Indeed, at such times we have actually observed an entire absence of all moisture in soil to about this depth. It is evident that when the water is coming from below this point, the humus or other surface conditions of forest can have little effect upon the rate of its drainage into the streams.

Historically, we have found little or no evidence that the very highest floods rise any higher than formerly. On the Passaic there is no record of a greater flood than that of September, 1882. On the Raritan there have been three great floods during the century, namely, November 24th, 1810; July 17th, 1865; September 24th, 1882. Of these, the first and the last were of almost exactly equal volume, while that of 1865 was a little lower. On the Delaware we have records of a great flood in 1692, which had not been equaled up to 1765. Smith's History, Chapter XII. This is said to have been due to the melting of snows. Another great flood occurred in 1786, the height of which is recorded, and of which we estimate the volume at Lambertville at 175,000 cubic feet per second. In 1801, 1814, 1836 and 1839 there were floods reaching from 140,000 to 150,000 cubic feet per second. On January 8th, 1841, a disastrous flood occurred, reaching 255,000 cubic feet per second. On June 8th, 1862, there was one of about 224,000 feet per second; the others since 1841 have not reached as high a point as that of 1862. It is evident that there is nothing in the history of these floods which clearly indicates any progressive increase in the volume of floods, but it is alleged, and is probably true, that floods of a less volume, or say from 150,000 to 175,000 cubic feet per second, are more frequent than they were formerly.

We also have investigated some recorded heights of the Delaware since 1831, at extreme low stages. These seem to indicate that the recorded flow in September, 1881, which we have given in our table at the rate of .19 cubic feet per second per square mile, is the lowest stage reached by the river since 1831, but it is also true that the drought of 1880 and 1881 is the severest of which we have any record during this period. We certainly have no record of any pro-

gressive falling off in the very lowest stages of the Delaware, but it is alleged, and probably with some truth, that stages which are low, although about 50 per cent. greater than the lowest recorded, last longer and are more frequent than they were formerly.

It must be remembered that in the foregoing examination we have spoken only of the very highest and very lowest stages of rivers, and we have done so because it is frequently attempted to show by these highest and lowest stages as recorded the injurious effects of cutting off the forests. We believe this to be an error, and that no effect can be discovered in this way, but it must be remembered that such stages are not important ones on a stream. We have seen that the very greatest flood on the Delaware has not been equaled again during the century, and so on the Raritan there have been but two such floods during the century; while, if we take the record of gaugings on the Passaic river for 17 years we find that the highest rate of flow, of 24 cubic feet per second per square mile, has been reached but once, and then only lasted for about 3 hours, while the lowest rate of flow, of .19 cubic feet per second per square mile, has not been reached probably more than two or three times for a few days in each case; whereas, the river has stood during this period between .4 and 1.34 cubic feet per second per square mile, an average of 112 days, and between 1.34 and 3.35 cubic feet, also an average of 112 days during each year, while it has been over 14.7 cubic feet per second per square mile only 8 days in the whole 17 years. It is evident, therefore, that what is really of importance on the Passaic is anything that affects the stages between about .3 cubic feet and 2 cubic feet per second per square mile, and that such cause would be infinitely more important economically, and its effect would be much more noticeable than causes affecting the extremely low or the extremely high stages. It is in those stages of the river which prevail during six months of an ordinary dry period that we believe the beneficial effects of forests are really found. The soil and sub-soil of a water-shed hold a large amount of water which is fed out as drainage, in the form of springs and seepage, to the stream during dry periods. It is a matter of common observation that at such times rivers continue to flow when rainfall is very much less than the evaporation, and, indeed, for long periods when there is no rainfall at all. Anything which tends to increase this amount of water which is held in the ground, and to regulate its discharge into the streams, tends to give a larger flow, and to shorten

the periods of very low water in the streams during droughts, and with this increased capacity of the ground to absorb rain comes also less frequent floods. The more water that is drained out from the soil the more can be absorbed when the heavy rains come at the end of the droughts. Humus in the forest forms a great sponge, and of itself holds a large amount of water, while it and the inequalities caused by tree roots, &c., tend to prevent the water flowing over the surface, and the roots of the trees provide channels by which the water percolates into the sub-soil readily. In this way the forest will easily absorb a larger amount of water than open lands. A high state of cultivation also has a tendency to increase the capacity of the ground to absorb water because of constant loosening of the surface and the facilities provided for ready drainage. In this way cultivation, like forests, tends to render floods less frequent, but the effect of the drainage of the soil is that the ground water absorbed is fed out more rapidly to the streams during the early months of a dry period than is the case in forests; consequently, the ground water is sooner exhausted, and the duration of the low stages of the rivers during protracted droughts is thereby lengthened. Barren water-sheds offer much less capacity for absorption of rainfall. There is no humus or other matter on the surface to retain the rain, and the ground becomes hard and resists free percolation. The difference between forested and deforested water-sheds is very well illustrated by the Passaic and the Raritan respectively, while some of our small red sandstone water-sheds are good types of barren country. We have, in the following table, contrasted these three types, the data being obtained from the Report on Water-Supply. This table shows in inches of rainfall the amount of water which would flow off to the several streams from their water-sheds for each month, during a drought of such a character that all additions from rainfall, or depletions from evaporation, to the ground water are suspended, the water here shown being entirely water of drainage.

YIELD OF SPRINGS ON VARIOUS TYPES OF WATER-SHEDS DURING DROUGHT.

IN INCHES OF RAINFALL.

Month.	Passaic. Type of forest water-shed.	Raritan. Type of highly-cultivated water-shed.	Type of barren water-shed.
First	1.16	1.43	.94
Second	.54	.64	.38
Third	.40	.45	.26
Fourth	.33	.35	.20
Fifth	.32	.30	.14
Sixth	.31	.27	.12
Seventh	.30	.25	.10
Eighth	.29	.23	.08
Ninth	.28	.22	.07
Total	3.93	4.14	2.29

It will be observed that while the Raritan and the Passaic show nearly the same total amount of drainage, the Raritan gives up this water faster in the early months, and, therefore, its springs become sooner exhausted and it runs lower toward the last of the drought. The barren ground, having absorbed much less water, has less flow from springs throughout. How important this is upon the dry-season flow of these streams becomes apparent from the following table:

FLOW IN GALLONS DAILY PER SQUARE MILE DURING THE LAST EIGHT MONTHS OF THE DRIEST YEAR (1881).

	Passaic. Forested.	Raritan. Cultivated.	Barren water-sheds.
April	597,000	754,000	631,000
May	297,000	325,000	145,000
June	272,000	272,000	139,000
July	207,000	134,000	22,000
August	140,000	89,000	22,000
September	139,000	87,000	23,000
October	129,000	84,000	22,000
November	127,000	93,000	23,000

The conditions here shown are believed to be illustrative of the effect of forests upon stream-flow, and the comparative effects of cultivation and barrenness. We have found it a rule that the

heavier forested catchments furnish a steadier flow, better sustained during dry periods, and that while they are subject once in a great while to severe floods, nevertheless floods not quite so severe are less frequent than upon deforested catchments not highly cultivated. Flood-flow, it must be remembered, however, is largely a matter of topography, and while floods are heavy and frequent upon the deforested Raritan and Neshaminy, the same is true of the well-forested Ramapo and Pequannock, while they are extremely light upon the lightly-wooded Pequest. The economic importance of the effect we have noted lies in the greater value of forested streams for water power, and the smaller storage reservoirs needed thereon to furnish a given daily supply of water to cities. Illustrative of this, the Passaic will furnish for 9 months of the year from 100 square miles of water-shed, 45-horse power on 10 feet fall, whereas the Raritan will furnish but 41 and the barren water-shed 28-horse power. During the other 3 months the Passaic will furnish an average of 36, the Raritan 32 and the barren water-shed 20-horse power. To collect 570,000 gallons daily per square mile of water-shed, we shall need storage reservoirs of the following capacity: Passaic 84,000,000, Raritan 110,000,000, and barren water-sheds 126,000,000 gallons. The difference in cost of collecting a supply at the above rate per square mile, therefore, upon the type of streams selected to represent the forested and upon those representing the barren conditions, would be about $8,400 per square mile. Both the Passaic and Raritan exceed 800 square miles in catchment. For this area the saving would be $6,720,000.

Taking the same area, we find the excess of water power on the forested stream would be for 100 feet fall, 1,360-horse power, the value of which, at a rental of $35 per horse power per annum, would be $47,600, or the interest at 5 per cent. on $952,000.

We do not advance these figures as exact measures of the value of forests, but they may be taken as indicative of the possible financial loss which might result in stream-flow alone from deforesting such of our water-sheds as are not adapted for cultivation.

It will also be seen how amply this effect of forests in increasing the stream-flow for 5 or 6 months during the latter part of a dry period justifies popular opinion as to a falling off of streams when the forests are cut off. Such effect is very much more likely to impress itself upon the popular mind than an increase of evaporation,

for this would tend to decrease the total run-off for the year without being very apparent to ordinary observation. Being a much more enduring effect, it would also be more noticeable than any change in the very greatest or very least rate of discharge.

Most of the portion of the State now in forest is not adapted to cultivation. It should remain in forest, because it will in no other way yield revenue; because it is needed to maintain the equable flow of our streams, and because it renders beautiful what would otherwise be an unsightly waste. Unless the State is prepared to assume the ownership of forest lands, the continued good condition of the forests can only be secured by instructing the owners how they can improve this condition, and, at the same time, increase their revenues. It is especially important that our Highlands forests, for the future gathering-grounds for our city water-supply, shall continue to be preserved and improved, as they undoubtedly have improved during the last quarter century.

Devastation caused by fire in a white cedar swamp, Gravelly Run, Atlantic County.

REPORT ON FOREST FIRES FOR SEASON OF 1895.

BY JOHN GIFFORD.

Professor J. C. Smock, State Geologist, Trenton, N. J.:

The following is mainly a report of progress. A more detailed report, relating to forest fires in South Jersey, to the "Plains," an interesting pitch-pine coppice in Ocean and Burlington counties, forest planting along the seacoast and methods of fixing moving sand, and the cultivation of the white pine, white cedar and other trees for financial profit, is in preparation. Since the presentation of the preliminary report, relating, in a general way, to the forests of South Jersey, besides a reconnaissance tour in the northwestern part of the State, the forestal conditions along the seacoast and tree planting on the beaches have been studied and facts relating to forest fires in the southern interior have been collected. The forest-fire question has received special attention, with the hope of suggesting a practical plan for the checking of this great evil.

Unless this wholesale destruction of useful property is reduced the coastal plain of New Jersey will soon approach a condition little better in appearance than a desert, but, as in England, owing to its almost insular position, the general climate is probably slightly affected by the destruction of a forest cover. Nevertheless its removal will be, if not already, seriously felt in the irregularity of the water-flow and the exposition of sandy soils to the force of winds and rains and the scorching rays of the sun, to say nothing of the extinction of several industries directly and indirectly dependent upon the forest. Never before, to the knowledge of the writer, owing to the extreme drought, have fires been more destructive than during the season which has just ended. In other years they have burned over larger areas of upland, but recently, for many days, they

consumed the humus and litter in the bogs and swamps, the dampness of which is usually sufficient to stay their progress.

Parts of the northern section of the State suffered also from fires. They are almost as frequent and, indirectly, as destructive on the Kittatinny and Bearfort mountains as in the sandy pine regions of the southern part of the State. The soil on these mountains is so thin and poor, if not wholly lacking, that trees have difficulty in growing. The forest cover is therefore light; the pitch-pine, with a scrubby undergrowth, predominating.

There are signs of frequent fires on the Green Pond, Bowling Green and Copperas mountains. In fact, throughout the whole of the wooded part of the northwestern section of the State fires are not infrequent during dry times. They are due both to carelessness and maliciousness. It is claimed that many are set carelessly by hunters, and by wood thieves in order to destroy the stumps and branches, which are evidences of their mischief.

The mountains of Northern New Jersey are justly noted for their beauty. The revenue from tourists alone soon amounts to as much as the woods are worth. Forests are probably of as much pecuniary value in adding to the attractiveness of these regions as in their yield of timber. The same is so of the pine regions in the southern part of the State, which, in their present condition, tend to repel rather than attract the tourist.

Owing to the extreme dryness, however, fires have occurred almost everywhere. On the slopes of the Watchung mountain, and even in wood lots in almost deforested areas in Central New Jersey, fences and crops along railroads were destroyed, rendering it necessary to furrow the ground for the protection of farms.

To obtain accurate information on this subject, blanks were prepared and men were paid to visit fires and prepare a description explaining how, when and where they started, how long they burned, the areas devastated, the nature of the timber, and the efforts to subdue them.

Owing to the frequency of fires throughout the State it was impossible to obtain a record of everyone, so an area of land embracing Atlantic, part of Burlington and Ocean counties was selected, since this region has been exposed to the ravages of fire for many years. A map showing the area burnt over is in preparation.

On the average, fires are more frequent in Atlantic and Cape May

counties. This is, probably, mainly due to the facts that the forest area is large and continuous, and the region is traversed by several railroads over which many trains pass in the course of a day in summer, in transporting large numbers of people to the seashore. One of these railroads has taken very few precautions, and, judging from the way sparks are showered into the air, it is indeed a wonder that any combustible property is left along its line.

In Ocean county fires did little damage this year. This is due mainly to the fact that, after the severe fires of the season of 1894, there is little combustible matter left to burn on thousands of acres in the region of the plains and southward to the Mullica river.

Fires burned as follows in the pine lands of Ocean, Atlantic and Burlington counties:

1. March 18th, 1895.—Lasted two days; set by spark from locomotive; medium-sized pine and small oak; pine slightly damaged, oak killed; 100 acres; near Dacosta.

2. March 20th, 1895.—Lasted one day; set carelessly by a tramp; small oak; seriously damaged; 60 acres; near Walker's Forge.

3. March 22d, 1895.—Lasted two and a half days; cause not known; medium-sized pine and oak; 3,000 acres; between Harrisville and Green Bank; loss in timber estimated at $8,000.

4. March 26th, 1895.—Lasted five days; set by spark from locomotive; damaged 2,400 acres of oak and pine timber; loss estimated at about $2,000; near Estelle Station.

5. March 28th, 1895.—Lasted three days; incendiary; pine and oak timber; badly damaged; 2,000 acres; near Washington Tavern.

6. March 29th, 1895.—Lasted one-half day; spark from locomotive; slightly damaged 50 acres of pine and oak timber; near Egg Harbor City.

7. March 31st, 1895.—Lasted one day; haymen were burning salt meadows, which is customary at this time of the year, and the wind suddenly shifted, and they were unable to keep the fire out of the neighboring woods; it burned through Griscom's Swamp, an interesting and valuable hard-wood forest in the southernmost corner of Atlantic county; it contained beeches, tulip trees, hollies, pines, white cedars, sassafras and some very fine swamp white oak, bilsted and willow oak; burned over 900 acres; damage estimated at about $3,000.

8. April 11th, 1895.—Lasted one and one-half days; set from a burning brush-heap; 600 acres; oak and pine; badly damaged; near Estelle.

9. April 11th, 1895.—Lasted one-half day; spark from locomotive; 100 acres; near Elwood; timber of little value, having been burnt over many times before.

10. April 17th, 1895.—Lasted one-half day; spark from locomotive; 300 acres; small oak; on Weymouth tract.

11. April 18th, 1895.—A succession of fires for six days; sparks from locomotives; near Elwood; 3,000 acres; medium-sized oak and pine; badly damaged.

12. April 18th, 1895.—One day; spark from locomotive; 1,000 acres; small pine and oak; oak killed; three miles below Egg Harbor City.

13. April 19th, 1895.—One day; spark from locomotive; 1,500 acres; pine and oak; oak killed; near Egg Harbor City.

14. April 19th, 1895.—Slight fire near Bulltown; attributed to carelessness with tobacco pipe.

15. April 20th, 1895.—A slight fire near Pleasant Mills; attributed to careless smokers.

16. April 21st, 1895.—Lasted five days; spark from locomotive (?); medium-sized oak and pine; 15,000 acres; near Tuckahoe. Several houses were saved with difficulty, and $1 per acre is a low estimate of the damage.

17. April 21st, 1895.—Lasted one day; supposed incendiary; near Bakersville; 700 acres; medium-sized pine, with heavy growth of underbrush; killed.

18. April 21st, 1895.—Lasted one day; cause not known, although rumor has it that an intoxicated man was near the fire when it started; near Newtonville; killed small oak and pine on about 1,000 acres.

19. May 10th, 1895.—Two days; accidentally set in clearing a safety strip around a cultivated cranberry bog; near Cedar Bridge; burned over about 2,000 acres, part of which was in thrifty oak and pine from 3 to 10 inches in diameter. The timber was killed, and having little commercial value, owing to its distance from a railroad, will rot in the woods to breed insects or furnish fuel for future fires. In addition, about one acre of cranberry bog, $200 worth of fencing and a large prospective huckleberry and cranberry crop were

destroyed. It burnt over to the eastern edge of the West plains, where it was whipped cut without much difficulty.

20. August 5th, 1895.—Lasted one day; spark from locomotive; 60 acres of young oak and pine; near Doughty's Tavern.

21. August 9th, 1895.—Slight fire near Doughty's Tavern; caused by railroad; promptly extinguished.

22. August 10th, 1895.—Slight fire on Millville road; spark from locomotive; promptly extinguished.

23. August 14th, 1895.—Slight fire near Dacosta; caused by spark from locomotive; promptly extinguished.

24. August 14th, 1895.—Slight fire near Elwood; caused by spark from locomotive; extinguished by section men. About this time there were innumerable petty fires along railroads, most of which were extinguished by the section men.

25. August 15th, 1895.—Lasted one-half day; spark from locomotive; near Elwood; 300 acres; medium-sized pine and small oak; oak killed, pine slightly damaged.

26. August 15th, 1895.—Lasted three days; origin not known; near Brigantine Junction; 350 acres; pine and oak; oak killed.

27. August 16th, 1895.—Lasted three days; spark from locomotive; near Brigantine Junction; 3,000 acres; medium-sized pines, with thick undergrowth of young oak; very badly damaged; 100 cords of wood, cut and ranked, were also destroyed.

28. August 19th.—Lasted two days; spark from locomotive; pine and oak of medium size seriously damaged on about 500 acres. This fire occasioned considerable excitement. A strong wind swept the fire at a rapid rate toward the town of Gravelly Run, which was in jeopardy for some time. By back-firing along a road, under the direction of an experienced person, and by hard fighting the houses were saved.

29. August 19th, 1895.—Slight fire on Taylor's meadow property, near May's Landing; carelessly or purposely set; promptly extinguished.

30. August 19th, 1895.—Lasted two days; spark from locomotive; three miles north of Pleasantville; 300 acres; low oaks and pines.

31. August 19th, 1895.—Lasted about twenty hours; incendiary was convicted; burnt over about 1,000 acres; destroyed 50 acres of cranberry bogs; one-half mile east of Jackson pond to head of

Atsion meadows. Two smaller fires in the same section were started previously but were promptly extinguished.

32. August 22d, 1895.—Six hours; on Atsion road from Hammonton; accidentally or purposely set by berry-pickers; fire was extinguished without much damage having been done.

33. August 23d, 1895.—Five hours; on Atsion road from Hammonton; 300 acres; set either accidentally or purposely by berry-pickers.

34. August 23d, 1895.—Three and one-half days; near Buena Vista; spark from locomotive; 1,100 acres of oak, pine, cedar and maple; said to be damaged $2 to the acre.

35. August 24th, 1895.—Lasted one day; set by spark from locomotive; near Buena Vista; 500 acres; pine slightly injured; oak killed.

36. August 25th, 1895.—Lasted one and one-half days; spark from locomotive; near Egg Harbor City; 2,000 acres; pine, small oak and white cedar; killed; some cut lumber and rails on Senator Gardner's place, near Goose Pond, were burned.

37. August 26th, 1895.—Lasted one day; spark from locomotive; started two miles below Folsom, near the swamp on Great Egg Harbor river; deciduous swamp; 100 acres; damage slight.

38. September 4th, 1895.—Lasted ten days; supposed to have been carelessly set by cranberry pickers; started at Crane Pond, not far from Carmantown; 1,200 acres; burned everything before it; cedar swamps, pine woods and oak fit for cord-wood. In spite of two showers and constant watching, several fires started in the meantime in the region very mysteriously. This fire did a very great deal of damage; a large quantity of saw timber was consumed.

39. September 4th, 1895.—Lasted one day; started in an old field near Carmantown; entirely destroyed thrifty young pine and oak on about 300 acres; this fire was carelessly set by a feeble-minded man while burning brush.

40. September 12th, 1895.—Lasted twenty-six days; started by party clearing land; they were burning turf and brush and were unable to control it; near Green Bank; although the timber was not very valuable, the greater part of it, on about 10,000 acres, was killed; a few acres of cultivated, and many acres of wild cranberries and huckleberries were seriously damaged.

41. September 14th, 1895.—Lasted five days; escaped from a work-

man while burning brush; near Bakersville; 4,000 acres, covered with timber fit for market wood; completely ruined; 50 acres of cranberry bogs were burned, destroying the entire crop.

42. September 14th, 1895.—Lasted one day; set by a feeble-minded person while lighting his pipe; consisted of oak fit for cord-wood; some white cedar and pine fit for saw timber, and several acres of cranberry and huckleberry swamps; killed everything on about 1,400 acres; destroyed $500 worth of fencing and a stable; a recently planted chestnut orchard and about 100 cords of wood, cut and ranked, were saved with a very great deal of difficulty; in many places the surface of the earth was burned clean, leaving nothing but stump holes to indicate that trees ever grew there.

43. September 15th, 1895.—Slight damage; set by mistake near Weymouth in back-firing.

44. September 15th, 1895.—Slight damage; near Bulltown; set by careless smokers.

45. September 22d, 1895.—Lasted three days; set by Italians accidentally while working in the woods near Weymouth; 2,000 acres of cedar, pine and oak seriously damaged. A barn was also destroyed. The village of Weymouth was in jeopardy from the flying sparks.

46. September 27th, 1895.—Lasted two days; on the Atlantic cranberry bogs; either carelessly or maliciously set by berry-pickers; 1,200 acres of cranberry land destroyed, including gates, turf banks and about 5,500 bushels of berries on the vines. Loss estimated by a competent person at $20,000.

47. October 4th, 1895.—One day; incendiary; near Atsion; 500 acres of young timber destroyed.

48. October 15th, 1895.—About ten days; set by spark from locomotive near McKee City. This fire was held in check for some time by the section men. It was burning in such a way in the swamp land that they were unable to extinguish it. It swept over about 2,000 acres. It destroyed a very great deal of fine cedar fencing and a sawmill belonging to Colonel John McKee. It entered Gravelly Run cedar swamp and caused a very great deal of destruction, not only consuming some of the finest white cedar in the State of New Jersey, but burned the corduroy roads which lead into the swamp. Old woodmen claim that they have never seen it equaled for havoc. Many trees from 10 to 18 inches in diameter, close

together, very straight and free from limbs 35 feet from the ground, tumbled over in every direction, forming large, impenetrable masses of charred timber.

During the season of 1894 the region of McKee City suffered from a severe fire caused by a careless workman, and many years ago, it is said, the village was completely destroyed by fire.

49. October 22d, 1895.—One day; spark from locomotive; about five miles east of Atsion; mostly savanna land of little value. The small pines on about 300 acres were killed.

Besides these mentioned above there were many destructive fires in Cape May county, an account of which will be sent to you as soon as possible.

SUMMARY.

First fire occurred March 18th; last fire, October 22d. The forest fire season usually begins about the middle of March and ends about the last of October.

There were forty-nine fires in all. Several were burning at the same time, and one lasted for twenty-six days.

Many not mentioned in this report were promptly extinguished without doing damage; others burned unhindered for several days, causing no end of destruction.

There were 7 in March, 11 in April, 1 in May, none in June and July, 18 in August, 9 in September and 3 in October.

March.	Three caused by sparks from locomotives. One by a careless tramp. One, cause not known. One, incendiary. One, escaped from haymen burning meadows.
April.	Six caused by sparks from locomotives. One, careless workman burning brush. Two, careless smokers. One, incendiary. One, cause not known.
May.	One, escaped while burning a safety strip in order to protect cranberry bog from fire.
August.	Thirteen, sparks from locomotives. One, incendiary. Three, carelessly or purposely set by berry-pickers. One, cause not known.
September.	Two, carelessly set by feeble-minded persons. Three, carelessly set while burning brush. One, set carelessly or maliciously. One, set by an Italian back-firing in the wrong way. One, set by careless smokers. One, set accidentally by Italians cooking in the woods.

October. { Two caused by sparks from locomotives.
One, incendiary.

Sparks from locomotives, 24.
Maliciously, 4.
Accidentally and carelessly, 20.

To this list, mainly to show the causes of fires, one due to lightning may be added. This fire did no damage, however, since the rain which soon followed extinguished it.

It is interesting to compare this record with that of the whole State, prepared by Professor Cook, for the season of 1880. There were 54 fires in all; 28 were due to locomotives, 13 were caused carelessly and 7 were caused through malice.

Of course, it is impossible to say that all these fires were positively set in the ways mentioned above. It is a difficult matter to determine the causes of many fires, and no doubt many are of incendiary origin for which railroads and careless individuals are blamed.

Wherever railroads have taken ordinary precautions in the way of spark-arresters, a cleared strip along both sides of the road, with furrows along the edges, and by ordering their men to check all fires in their incipiency, the number and destructiveness of fires have been very materially reduced.

The area devastated by the fires recorded above, in Atlantic county and a large part of Burlington and Ocean counties, amounts to about 60,000 acres. Including cranberry bogs and other property destroyed, besides the timber, the average loss per acre is placed at $10 by several very competent land-owners. It is, however, an impossibility to estimate the damage. This much is certain, however, that several hundred thousand dollars worth of useful material was consumed. It is also certain that this destruction is rapidly depopulating certain sections.

Three fires, the causes of which are not at all known, seemed to flare up spontaneously. The contents of a pipe, a lighted cigar stump or a combustible gun wad is probably accountable for the mischief.

In a region of berries, although perhaps a mystery at the time, it often becomes known later, that fires were set to improve the berry crop. An observer from Ocean county writes: "The natives are suspicious of me, thinking that I will have them punished for starting a fire. Many of them think that fires improve their berry crops, and like to see them burn." There is no room for doubting that fires are

set in that way; in fact, some do not hesitate to acknowledge that they have set fires for that purpose. When a land-owner refuses to let people pick wild berries on his property, fires are often started out of spite.

Usually, owing to the dampness of the swamps where the swamp-berry grows (*Vaccinium corymbosum*), the lower parts of the bush are but slightly affected by fire. This plant often attains the size of a small tree, and a fire in passing, during moist times, causes little more than a severe trimming. During the past season, however, owing to the extreme dryness, the bushes were entirely killed. The destruction of the wild huckleberry and cranberry crop will be seriously felt next season by the very persons who have been careless with fire heretofore. There are several indications that people have set fire in times past in order to get the job of helping to extinguish it. For years colliers fired the woods so that they could buy the wood cheaply. The charcoal industry, although at one time a very important one, amounts to very little at present in South Jersey. If a man has no money and is out of a job and knows that the owner of the land will pay him for helping to extinguish a fire, it is a simple matter for him to make work for himself. This, it is claimed, has occurred not very infrequently on large tracts belonging to well-to-do non-residents. Two very serious fires were set in Atlantic county by two feeble-minded persons. They are hardly fit for an asylum, yet not altogether responsible for what they do. Incendiary fires are usually the most destructive, and there is no way in which the cause can be better served than in the conviction and imprisonment of malicious and reckless fire-setters. Fires set by sparks from locomotives, although frequent, are generally not so serious for at least two reasons: The land along railroads has been burnt over so many times that there is little food for fire left, and section men usually endeavor to put out fires caused in that way.

One man in Ocean county set fire to the woods accidentally while endeavoring to burn a safety strip around his bog. Several fires of a very serious nature were caused by burning brush in a careless manner.

The leading industry in the southern part of the State, the cultivation of the cranberry, has been seriously crippled by fire. It is a constant menace to the bogs during the dry season. Wide, cleared strips around bogs and storage reservoirs cannot be too strongly rec-

ommended. The destruction of the forest cover has interfered with the regularity of the water-flow to such an extent that water is often lacking when most needed. The cutting of cedar swamps, which are usually full of springs, has also seriously affected the water flow. Several cranberry growers have surrounded their bogs with wide strips of cleared land, and constructed reservoirs in order to insure a supply of water in times of drought.

The soil must be very dry and the fire unusually fierce to burn a swamp of white cedar. Although seldom completely destroyed, the cedars on the edges, at least, are usually killed. This can be very easily prevented by surrounding the swamps with a strip of cleared land.

The hundreds of black boles, which remain to rot in the woods after a fire, in former years were used for the manufacture of charcoal. They are not only ample warnings to capitalists and an obstruction to new growth, but form a nidus for the propagation of pestiferous insects. Many pines have been killed this season by the pine-beetles (mainly *Dendroctonus terebrans*). The following is quoted from *The Forester*, a treatise on forestry by Brown and Nisbet:

"All dead branches and the *débris* of thinnings should, in all cases, be removed from woods and plantations, and should not, under any pretext, be allowed to lie upon the ground for any length of time after they are cut off from the fallen trees. In plantations, fallen branches and the remains of a course of thinning are often left lying to rot upon the ground without any attention being paid to gathering them up or burning them. Such a system cannot be too much condemned, as it is not only opposed to good management, but such dead and decaying branches are also just the breeding places where most of the dangerous insect enemies of forest trees are generated. By removing these branches, and either burning them or converting them into faggots for firewood, a great benefit to the plantation will be the result. In thus keeping all plantations free from small material of this kind, it will be found that they will not be liable to be infested with injurious insects. The after-health of the growing crop will fully compensate for any expense that may be incurred in the operation of clearing and destroying the branches, even although the latter can be put to no profitable use. All foresters, therefore, who wish to have the woods under their charge in a good state of health and as free from the ravages of insects as possible, should use every possible means to have all small poles, branches and brushwood cleared away as soon after thinning as possible."

This does not refer to the living underbrush. The decaying leaves on the surface and living underwood are essential. The main injury caused by a ground fire is the destruction of this surface covering, which exposes the soil to the action of the sun, wind and rain. After cutting, masses of decaying wood remain on the ground. Every woodland owner, after cutting, ought to be prevailed upon to destroy this decaying material at once. This should be done under the direction of an officer of the State, in case it is at a time when there is the slightest danger from fire. By leaving this material to rot on the ground, one person injures his neighbors' properties in two ways: (1) Increasing the danger from fire and (2) by breeding insects which may infest the neighboring woods.

Persons living in small towns in forest districts, if not already, will feel the effects of this destruction by fire, since woodland owners are justified in demanding a reduction in the amount of taxation.

Much could be said of the work of fire in the swamps and bogs during the season which has just ended. The swamp bottoms, through which many streamlets usually percolate, became as dry as punk. It required but the slightest spark to ignite this mass of tinder. Many of these fires burned slowly, one lasting for almost four weeks in spite of a hard shower in the meantime. At night they smouldered. Both sand and water, with which to fight it, were lacking in the swamp, while beating with brush and shovels only increased its severity. In such places it is often necessary to dig trenches through the swamp to stop its progress. The air was filled with dense clouds of smoke, on the particles of which, at night, the moisture of the atmosphere congealed, causing it to float near the surface of the earth. During the month of August, in spite of the heat, even in the larger towns in South Jersey, it was necessary to keep all windows and doors closed in order to keep out the smoke. Along the coast it occasioned a fog. It was not uncommon during the month of August to see smoke rising from four fires at once. These fires burned several feet under the surface, destroying in a short time the humus which has been many years in accumulating. Good authorities claim that this covering of decayed vegetable matter forms at the rate of one foot in from one to four centuries.

Here and there throughout the woods there are shallow ponds with clumps of swamp huckleberry bushes and cranberry vines around their edges. During the drought the water evaporated and the mud

on the bottom became so dry that the fires in passing left nothing but white sand and ashes.

In many swamps consisting mainly of deciduous trees the parts of the trees above ground were not burnt, but the roots were destroyed, killing the trees, of course, in consequence. Large numbers have fallen in every direction, forming large piles of dead wood. Others are blown down by every wind. In several places fallen timber has obstructed public roads. Another dangerous fire may start at any time in this mass of *débris*.

For several miles it is impossible to find a green tree of any size. The ground is covered with charred sticks and fallen tree trunks. Here and there a patch of pure white sand is visible. In many places large stump-holes are the only indications that trees ever grew there. It is difficult to imagine a more desolate spectacle.

It requires no argument to convince every thoughtful person that the reckless destruction of useful property is wasteful. The difficulty, however, is in suggesting effective and inexpensive preventive measures. It is evident to all that, in order to put an end to forest fires, they must be prevented or checked in their incipiency rather than to lose time and money in fighting them after they have become formidable. In other words, the remedy is preventive and not curative. At present the main difficulty is that a fire in the woods, in many cases, receives no attention whatever until it becomes dangerous. The reason that woodland owners have taken no precautions for the prevention of fires is mainly that they are willing to take the risk, as great as it is, rather than expend money on their properties. After the damage is done they are, of course, still less inclined to pay for the construction of fire lanes for the protection of property which is worth very little, and which will yield no revenue for several years. Every woodland owner knows the efficacy of the proper kind of fire lanes.

In many regions a fire is left to itself until night, when it smoulders. If the owner of the property is away and no one is left to care for it, fire may sweep over it, and the majority of people in the region will pay little attention to it until their own properties are endangered. Even if watched for years, at an unexpected moment an incendiary may start a fire on your neighbor's property, if not on your own, and not only your wood, but 50 years of watching and fire fighting count for nothing. With no protection whatever, with a slight chance for

reimbursement, which is meagre at best, and with a tax rate which is high in proportion to the yield of ordinary woodland, there is little wonder that many land-owners are discouraged, and that forest property is passing into the hands of non-resident capitalists, who are able to hold it with other objects in view than the growing of forests.

In speaking of a severe fire in the region of Weymouth, an observer says:

"Much of the land burned over in this region during the past season was covered with a growth of from 25 to 50 years of age, which, with great care and at great expense, had been preserved from fire all these years. A liberal tax has been paid, and it is only reasonable to expect that the present owners will demand a reduction of assessment, which will make a very perceptible difference in the local tax rate."

In the majority of cases there is a lack of method in subduing a fire. There is a general indifference to fire for several days; there are mistakes in fighting, resulting from fear and lack of experience; there is always a lack of organization and judgment with volunteer fighters; there is the frequent undoing of work already accomplished, because of the absence of watchers after the flames have been controlled; there is often discouragement, and one party of fighters may leave without informing the other party or parties; there is difficulty in arousing the people even when danger is imminent; there are many instances where fires are permitted to sweep by vantage points, such as roads or streams, through indifference or a lack of knowledge of the geography of the region; and in back-firing trouble is often caused when one man's property is sacrificed to save that of others. In spite of the smoke and heat it is remarkable, however, what one man can do, with nothing but a branch of a tree for a weapon, in "whipping" out fire. Many ground fires can be quite easily extinguished in that way. An experienced woodman, with a bush for a weapon, can whip out fire as he walks along its edge. At other times an army of men is powerless to check its advances in any other way than by back-firing from a stream, road or other point of vantage.

Mr. T. P. Price, of Tuckerton, speaks of the attempts to subdue the great fire which swept over a large part of Ocean and Burlington counties in 1894, in the following words:

"On Friday (July 13th, 1894) the fire raged across the country. I rode out into the woods to investigate. The main body of flames had swept by upon Stafford Forge and Manahawken, but the long flank was left, mile after mile of fire backing down toward Tuckerton. A northwest wind would, therefore, bring us instant and most alarming peril. An attempt was made to rally a fighting force, a harnessed team going at evening into the village, the danger and opportunity being both presented. The men acknowledged the truth of all that was said, but firmly took the stand that they ought to be paid.

"Are they not right? They do not own a foot of forest. The owners are capitalists living in New York, Philadelphia and other states and cities. Why should boatmen and laborers spend a night in severe and dangerous toil without compensation, fighting fire for absent owners? And again, Why should absent owners pay men to fight fire when they go out, an undisciplined mob under impromptu leadership, and when it is often too late to save the property? And again, Who shall telegraph the owners and get them to act?

"If anyone thinks townships can act, I reply, this fire burnt property in at least eight townships. For them to act as townships would be a wasteful and confusing policy.

"If the State acts by means of large districts, we shall have unity. This fire could have been put out a dozen times by a small State force, paid, officered, disciplined and known to have authority. The State taxes forest property and also the exposed towns. Does it not owe them protection? One cent per acre, annually, under wise organization ought to pay the cost.

"But Tuckerton was not rid of her fire. Nature has encompassed her with bays and rivers, and a merciful Providence held the wind continuously in a quarter from the sea. Still the fire slowly inclosed her.

"Alive to the folly of sitting still, another effort was determined upon. Knowing two good men who were willing to fight, it was decided to go out with these alone, if necessary, but there were hopes that the example would have inspiration. So it proved. We started one evening at six o'clock and by nine had fifteen or twenty men. Three or four miles of fire were subdued, and when we returned, wearied, at three o'clock in the morning, it was expected a fresh force would finish the arduous battle. But the fresh men never came, and the mile of fire left burning within forty-eight hours undid the work accomplished. Another proof of the need of organization.

"Other days pass, and again one afternoon the smoke arises black and near. I hasten forth, to find a Jew in the outskirts has been seized with a panic and has set a fire nearer, hotter and more dangerous than the one that frightened him. The new fire sweeps wildly before the wind, whereas the old fire had to burn against the wind.

"Fifty men sit looking on. Two things are evident. One is that nine-tenths of the people are mere spectators, the other is that a

section gang sent by a railroad, being paid for their time, expect to work. These men go into the line of fire, but the task before us is hopeless unless we can find a strategic point from which to fight. Fortunately, it is found at last, just in the nick of time, and by hard work and back-firing we gain the day.

"This fire, so narrowly brought under control, ought to have been watched, but with no system who is to do the watching?

"In a few days there is peril again, with the enemy at still closer quarters. Two bodies of men go out and begin by direct assault on each extremity of the fire. They are, perhaps, a mile apart. The thermometer in the woods is above a hundred degrees and the flames are like a furnace. The men lie down again and again from exhaustion. There is no drinking water. The woods are a tangled thicket of undergrowth and briars. No tidings come from one company of men to the other. No one knows whether the fight is maintained elsewhere, or how large a body of fire remains to conquer. Discouragement appears. Then a volunteer of one company undertakes to determine the situation. He finds two-thirds of the fire put out; the other company of men completely discouraged and on their way home, and a plucky worker fighting, single handed, in the middle of the line of fire, though ignorant of other helpers.

"A knowledge of the situation cheers everyone, and all return to work with a will. Drinking water is brought by a team, and in a brief space of time the battle is over. Many lessons appear, but they sum up in this: There must be organization and it is especially desirable to have good leadership."

In just such ways the majority of fires are fought in South Jersey. It is as difficult to get good men as it is to put out the fire. Everybody who will go is taken to the fire; a few work but the majority are spectators. Very often they forget to take drinking water. On one occasion, during the season which has just ended, the fighters had whiskey and crackers in abundance but no water.

In order to prevent forest fires there are three requisites: *Co-operation of the people*, especially woodland owners, *wide fire lanes* and *paid wardens*.

It is difficult to properly adjust communal and individual interests and rights. The conservation of the forest cover for the sake of the community is highly important. Fires are so destructive, wood so cheap, the time that invested capital must wait so long and the communal spirit in thinly settled regions so weak that a great deal of persuasion is necessary in order to induce woodland owners to change their methods or spend one cent more than is absolutely necessary on their forests.

Nevertheless, this is the first and most important step. Landholders may be divided into three classes: The farmers with their wood lots, the speculators in land who hold it temporarily, and the lumbermen and manufacturers. Unfortunately a large part of the land in South Jersey is in the hands of the second class. The first and third classes are the most important. Their co-operation is essential. In order to gain their influence it is necessary to convince them that the reckless destruction of forests is in the end as detrimental to their interests as to the welfare of the whole community. To respect trees we must know trees. Interest can be aroused by instituting courses of lectures throughout the State, by freely distributing literature on the subject, by introducing it to a limited extent in public institutions and by the appointment of a person or persons to furnish information on the subject to woodland owners.

Forestry associations, some of which have been aided by the States in which they are located, have already accomplished a very great deal in this line. If every person interested in forestry practices it on his or her own property it will have an appreciable effect. If a few construct fire lanes around and through their properties others will soon do likewise. It is gratifying to note that in the northern part of the State several persons are contemplating putting their forests under forest regulation. Mr. Theodore Havermeyer, on his estate near Mahwah, has employed Mr. F. R. Meier as forester. The work of thinning and planting is well under way. If the owners of large tracts in the southern part of the State would employ practical foresters to direct the work of cutting, attend to the regeneration of depleted areas and to the prevention of fire the problem would be almost solved.

One of the most practical steps toward the prevention of fire is the construction of fire lanes. The forest covers such broad areas in South Jersey that a fire can travel many miles without meeting with cleared areas of any extent. Even if a fire lane or cleared strip is not wide enough to stop the progress of a fire, it is always of value as a point of vantage in back-firing. General Elias Wright, of Atlantic City, describes a fire which occurred during the month of April, a few years ago. It "jumped" the Mullica river where it is 600 to 800 feet wide. By "jumping" is meant, of course, that the sparks flew to such an extent that they ignited the woods on the opposite side of the largest river in South Jersey. For all ordinary

fires a strip of cleared land 50 feet wide, if kept clear from combustible matter, would be very effective. In the case of ground fires, which do a great deal of damage and burn for several days without being noticed, a path through the woods, if the wind is not blowing, often serves to check their progress.

Fires lanes along railroads have proved very efficacious in South Jersey, especially those which have been furrowed along their edges. By keeping these lanes free from combustible matter the most prolific source of fires can be materially reduced. At present these lanes are insufficient, although the companies usually clear about 40 feet on each side from the middle of the track. At certain times sparks are thrown long distances.

Railroads are essential even to the woodland owner. His wood would be worthless without a means of transportation. There are many reasons why he should co-operate with the railroad and clear and keep clean about 40 feet along the railroad. The leaving of a strip of deciduous trees between the lanes is advocated by several. It beautifies the country and acts as a screen, preventing the sparks from flying over the outside lane. The expense of clearing such a strip would not be great. If spark arresters are used, ashes deposited in places especially prepared for the purpose and double lanes constructed, one by the railroad and the other by the land owners, fires from locomotive sparks would be much less frequent. In Europe there are fewer fires caused by railroads than any other cause except lightning. Mr. B. E. Fernow, in speaking of forest fires in Europe, says: "On the 6,000,000 acres of forest belonging to the Prussian government, during the 10 years (1882–1891), 156 fires occurred; 96 were due to negligence, 53 to ill will, 3 to lightning and 4 to locomotives." Seven years out of the 10 are without any record of fire due to the last cause. These 156 fires burned in all about 800 acres. This was considered a heavy loss from fire.

Public wagon roads will serve for fire lanes, if they are properly trimmed out and kept free from combustible material for at least a distance of 25 feet from the middle of the road. The wider, of course, the better. It is not necessary to cut down the large trees. They serve to keep the road in order by shading it, and also furnish a shelter from sun and wind. In their present condition fires not only sweep over them without much difficulty, since on many public roads the brush is so dense on both sides that there is barely enough

room for wagons to pass. Many fires are carelessly set by people in passing. A match or cigar is carelessly thrown from a wagon into the grass and leaves along the edge, and a fire is caused in consequence, without being noticed by the person who set it. This frequently happens. Instead of acting as lanes for the prevention of the spread of fire, railroads and public roads are the places where the largest number of fires start. Some have suggested that instead of employing several men to work at certain times on a road, that one man be given a piece of road to keep in order, not only busying himself with mending the small breaks before they become serious, but by patrolling the road continually, watching for and extinguishing fires which may be carelessly set, and by trimming the trees along its sides and burning the combustible material at the proper time. In that way what is now a source of danger may be turned into a lane which will effectually prevent the spread of fire.

Many land-owners have been consulted on this subject, and the opinion is almost unanimous that the widening, clearing and furrowing the edges of lanes along railroads, and the widening and clearing of certain public roads would be the most practical, efficacious and inexpensive step toward the prevention of fires.

Even in well-regulated forests fires cannot be wholly prevented. As in towns and cities, however, by organization the damage can be reduced to a minimum. It is even possible, in the course of time, to reduce the risk to such an extent that forest property may be made insurable.

Forest wardens are, of course, indispensable. The presence of an experienced person, with authority to act, is needed at every fire. Some one must have authority to say how, when and where to backfire. Some one is needed to apprehend and bring to court persons guilty of incendiarism, criminal negligence and wood thieving. Some one is needed to supervise the burning of brush and to see that the laws relating to the woods, and everything that concerns the woods, are properly enforced.

The following is a letter in reference to forest fires, from Mr. B. E. Fernow, Chief of the Forestry Division :

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY,
WASHINGTON, D. C., November 14th, 1895.

Mr. John Gifford, Mays Landing, N. J.:

DEAR SIR—The principles upon which effective forest fire legislation can be established are well known and tested by experience in certain portions of our country. You will find them discussed at greater length in the appended circular. Substantially these principles were embodied in the legislation, which now exists and is successfully enforced in the State of New York, enacted through the efforts of the late Senator Low, at whose request I drafted the bill. The same was copied, with modifications, to suit local conditions by the States of Maine, Wisconsin and Minnesota. Improvements, especially in the methods of carrying out the law are, to be sure, quite possible.

Organization is the keynote of success in dealing with the fire problem. We have recognized this in the cities and villages, where it was found that even the concentrated property interests did not afford protection without well-organized fire departments. Much more so is *organized* effort necessary in the country, where property is less concentrated and the single owner powerless to protect himself. In addition, the value of forest property being low per unit, although large in the aggregate, and its safety of more moment to the community at large than to the single owner, he feels both less capable and less inclined to exercise the care and incur the expense of securing its protection. Especially is this the case where, as in New Jersey, large tracts are held by absentees.

Fire legislation, no more than other criminal legislation, executes itself, hence the first requisite is a responsible officer charged with the enforcement of the law. This duty might be charged to one of the existing officers, but inasmuch as these have probably all the work they can attend to and as the organization of a fire service and the enforcement of the law will at least at first require close attention, a special fire warden is preferable. The organization of the fire service again could be by volunteers or by increase of duties of existing officers or by specially paid officers. At least in the less populated, most endangered sections and during the dangerous season only the latter class will be found effective.

There is no good reason why, therefore, in the northern hardwood and agricultural region the fire guards may not be unpaid volunteers —being paid only when actually employed in putting out fires—a system which has been successfully employed in some parts of Pennsylvania, while in the pineries of South Jersey the system of paid watchers should prevail.

A small force, properly stationed and instructed, ready at any time to put out incipient fires could unquestionably reduce the fire bug to insignificant size. These men should have sheriff's power to

arrest suspected incendiaries and also to raise a posse for the purpose of fighting fires. To increase their effectiveness a districting of the area they are to watch by roads or in the absence of these by fire strips, which might be burnt over in early spring, thus confining the danger upon smaller areas, is advisable.

The first objection—in fact almost the only seemingly valid one—would be as to the expense; but when it is considered that notoriously every year damage to the extent of several hundred thousand dollars is done to property, not to count the damage to the commonwealth and the future in wasting fertility and taxable value of the soil, an expense of $25,000 per year for such service, which would be more than ample, must appear insignificant and well spent.

This expense should be levid on the forest owners themselves according to their acreage, a charge of one cent per acre sufficing to insure their protection.

I hope you will be able to formulate legislation upon such principles as here outlined fitting the particular condition of your State, and that your legislature will see the prosperity of at least an honest attempt of blotting out the worst enemy of New Jersey's prosperity, at least in the southern parts—the forest fires.

Yours for rational treatment of our resources,

B. E. FERNOW,
Chief of Division of Forestry.

The following is a part of a circular which is being distributed by the Division of Forestry:

FIRE LEGISLATION.

The most harmful avoidable waste comes from losses by fire. Not only are enormous quantities of timber killed or deteriorated in value by the annual conflagrations, but by the burning of leaf mould and seedlings the ground is made barren and given over to inferior vegetation and scrubs, and desirable reforestation is prevented. It would be in the interest both of lumbermen and of communities to stop this waste. This circular, therefore, appeals to lumbermen not only to enjoin upon their workmen the necessity of a more careful use of fire, but also to be instrumental, especially by associated effort, in bringing about the enactment and enforcement of proper fire legislation. There is no reason why forest property should not be as well protected by the community as any other property, and protection will be afforded if the owners insist upon it.

Following is the draft of a bill which can be applied, more or less

modified according to circumstances, in every State, its main features having been drawn from the law enacted for the State of Maine in 1891, and there successfully applied. The writer would lay special stress upon the necessity of intrusting the enforcement of the law to an officer specially charged with and responsible for it. In several States fire legislation is in existence which is satisfactory, except that it lacks the proper machinery to enforce its application.

The principles most needful to keep in view when formulating legislation for protection against forest fires are—

(1) No legislation is effective unless well organized machinery for its enforcement is provided. The damage done by forest fires extending in many cases far beyond immediate private and personal loss, the State must be represented in such organization.

(2) Responsibility for the execution of the law must be clearly defined and must ultimately rest upon one person, and every facility for ready prosecution of offenders must be at the command of the responsible officer.

(3) None but paid officials can be expected to do efficient service, and financial responsibility in all directions must be recognized as alone productive of care in the performance of duties as well as in obedience to regulations. In the case of corporations the officers most directly responsible for any damage, as well as the corporation itself, must be amenable to law.

(4) Recognition of common interest in the protection of property can be established only by the creation of financial liability on the part of the community and all its members.

AN ACT FOR THE PROTECTION OF FOREST PROPERTY.

FOREST COMMISSIONER.

Section 1. Creates a forest commissioner, whose office may be either an enlargement of some existing office or, much better, a separate one, with adequate compensation in either case, to be appointed by and reporting directly to the governor.

Sec. 2. Prescribes the duties of the forest commissioner, namely, to organize, supervise and be responsible under the provisions of this

act for the protection of forest property in the State against fire. In addition, he is to collect statistics and other information regarding the forest areas in the State, and the commerce of wood and allied interests, especially such information as will explain the distribution, value, condition and ownership of the woodland. This information and the results of the operation of this act, together with suggestions for further legislative action, to be embodied in annual reports.

Sec. 3. Provides for the giving of a bond by the forest commissioner for the faithful performance of his duties, and fixes fines for such neglect in performing the duties of the office as may be proven, and explains the manner of imposing and collecting such fines.

ORGANIZATION OF FIRE SERVICE.

Sec. 4. Constitutes the selectmen of towns, or the sheriff's deputies, constables, supervisors, or similar officers, as fire wardens. If preferred, special fire commissioners may be appointed by the forest commissioner, with the advice of county commissioners, or both methods of providing fire wardens may be employed together. The towns are to be divided into fire districts, the number and boundaries to be governed by the exigencies in each case, and each district to be under the charge and oversight of one district fire warden. One of these should be designated as town fire warden, to take command in case of large conflagrations. The town fire warden, and at least 50 per cent. of the district fire wardens, should be property owners in the county, unless a sufficient number of such cannot be found or a considerable number refuse to serve. A description of each district and the name of the fire warden thereof are to be recorded with the forest commissioner and the town clerk or similar officer.

Sec. 5. Provides for employment of special fire patrols in unorganized places in any county and during dangerous seasons, especially in lumbering districts, and for co-operation of forest owners. Wherever unorganized places exist in a county or so far distant from settlements as to make discovery of fires and speedy arrival of regular fire wardens impossible, or wherever forest owners whose property is specially endangered require, the forest commissioner may annually appoint special fire patrols to be paid at daily rates, the owner paying one-half the expense and the State the other half, such patrols to be under the regulations of this law, and to report to the nearest fire

wardens. The manner of appointment and the matter of compensation and duties are to be formulated by the forest commissioner.

Sec. 6. Defines the powers and duties of fire wardens; to take measures necessary for the control and extinction of fires; to post notices of regulations provided in this law and furnished by the forest commissioner; to ascertain the causes of fires and prepare evidence in case of suits; to report each fire at once to the forest commissioner on blanks furnished, giving area burned over, damage, owner, probable origin, measures adopted, and cost of extinguishing; to have authority to call upon any persons in their district for assistance, such persons to receive compensation, as determined by the selectmen or county commissioners, at the rate of not to exceed 15 cents per hour, and to be paid by the town or county upon certification by the forest commissioner.

Persons refusing, when not excused, to assist, or to comply with orders shall forfeit the sum of $10, the same to be recovered in an action for debt in the name and to the use of the town or county, or for the fire protection fund.

Fire wardens shall be paid $10 a year as a retainer, besides days' wages at the same rates as sheriffs or similar officers for as many days as they are actually on duty, and shall be responsible for prompt extinction of fires and be amenable to law for neglect of duty. The district fire warden shall call on the town fire warden in case of inability to control fires, and the town fire warden shall have sheriff's power to enlist assistance, as provided in case of a mob.

FIRE INDEMNITY FUND.

Sec. 7. Provides for the creation of a fire indemnity fund, each county to pay into the State treasury $1 for each acre burnt over each year, the special fund so constituted to be applied in the maintenance of the system provided by this act and for the payment of damages to those whose forest property has been burned without neglect on their own part or on that of their agents.

The burned areas shall be ascertained by the county surveyor and shall be checked from the reports of fire wardens by the forest commissioner. All fines collected under the provisions of this law shall also accrue to the fire fund.

JURISDICTION AND LEGAL REMEDIES.

Sec. 8. Establishes jurisdiction and legal proceedings in case of prosecution of incendiaries and adjustment of damages, and imposes upon every district judge the duty, in charging the grand juries of his district, to call special attention to the penal provisions of this act and of any similar acts providing for offences against forest property.

Sec. 9. Charges the forest commissioner to issue and publish, by posters and otherwise, reasonable regulations regarding the use of fires, such regulations to contain special consideration of campers, hunters, lumbermen, settlers, colliers, turpentine men, railroads, &c., and to be approved by the governor.

Sec. 10. Makes it a misdemeanor to disobey the posted regulations of the forest commissioner, or to destroy posters, or to originate fires by neglect of the same; provides that the prosecution shall be prepared by the forest commissioner; and imposes fines and imprisonment in addition to damages. Fines should be double the actual damages, one-half to go to the fire fund, one-half to the person damaged.

Sec. 11. Makes it a criminal act, subject to indictment, to willfully set fires, and imposes fine and imprisonment.

Sec. 12. Any person whose forest property is damaged by fire not originated by his own neglect, and who is able to prove neglect on the part of the fire warden, may call on the forest commissioner for award of damages, whereupon the forest commissioner, in conjunction with the county authorities, shall investigate the case and shall refer his findings to the judicial officer of the district, who shall charge the grand jury to indict any offender against this act and adjudge any neglectful fire warden, or other officer, or any person refusing to act upon order of the fire warden.

Any neglect on the part of the forest commissioner to investigate and find in each case within one year from the appeal of the owner shall be followed by dismissal, unless reasonable cause for failure be shown.

LIABILITY OF RAILROADS.

Sec. 13. Charges railroad companies to keep their right of way free from inflammable material by burning, under proper care, before certain dates to be established by the forest commissioner. Failure

to do so upon notification by the commissioner shall be followed by the arrest of the superintendent of the section, who shall be liable *prima facie* to procedure under Section 10.

Sec. 14. Provides for the use of spark arresters, failure to comply with this provision to be followed by arrest of the superintendent or other officer in charge of the motive power and by procedure under Section 10.

Sec. 15. Fires originating from the tracks of a railroad company shall be *prima facie* evidence of neglect on the part of the company, and the engineer and fireman shall be liable to arrest and procedure under Section 10.

Sec. 16. In all cases where a fire originates through neglect of a railroad company or its agents, both the company and its officers shall be liable for damages under the provisions of Section 12.

Sec. 17. Establishes special liabilities for damage by fires in case of railroads under construction.

FIRE INSURANCE AND STOCK LAWS.

Sec. 18. Provides for the incorporation of forest fire insurance companies. In States where cattle are allowed to roam provisions to stop this practice should be enacted.

FURTHER DUTIES OF FOREST COMMISSIONERS.

Sec. 19. Defines minor duties of forest commissioners, namely, to co-operate with superintendents of schools and other educational institutions in awakening an interest in behalf of forestry and rational forest use.

Sec. 20. Provides for salary and other expenses of the office of forest commissioner, which should be liberal in proportion to the responsibility of the office.

Sec. 21. Repeals all acts and parts of acts inconsistent with provisions of this act.

NOTES ON THE FORESTS OF NEW JERSEY.

BY GIFFORD PINCHOT.

The following notes have been gathered during a very hasty survey of certain of the forest areas of New Jersey, and they should in strictness be taken to apply only to those places which I visited. Consultation with others, however, whose acquaintance with the surface of the State is far more detailed than mine, and whose observation of the uniform character of each of its two forest divisions confirms my own, has convinced me that the conclusions I have reached are applicable, so far as they go, to the whole area of the State.

These notes consider the forest altogether from the forester's point of view. That is to say, this question has been asked with reference to each piece of woodland examined, assuming that its proper function is to produce forest and not agricultural crops: How can the forest be made to yield permanently the largest possible contribution to its owner and to the commonwealth? In other words, What is the best system of management for the forest in view of the particular surroundings in which it is placed? The answer must vary widely in its details, following the very diverse character and circumstances of different pieces of forest. Longer and more careful study is often required to frame a satisfactory reply to this question for a single forest than could be given to the present rough survey of the whole State. Consequently no attempt is made in this paper to do more than bring together a few of the more obvious facts, and then to formulate in brief some of the general requirements which they indicate.

The forests of the State of New Jersey may be divided into two classes, separated from each other by the well-known line running nearly north-east and south-west through the State between Salem on the Delaware and Long Branch on the coast. North and west of this line the forest is composed of deciduous trees, mainly the Chestnut and several Oaks, and practically the whole area is sprout land. That is to

say, the great majority of the trees of this region have not grown from seed, but are shoots or sprouts from old stumps. The technical term for such forest is coppice.

Hitherto it has been the general custom, which still obtains wherever the fall of prices has not interfered, to cut these coppice woods clean as soon as they were ripe for hoop-poles, cord-wood, ties, charcoal, rails, or mine timber, as the case might be. The average age of cutting in the localities I visited is probably not far from thirty years. After the trees have been cut the old stumps sprout again, and the sprouts form the material of the new crop. If we suppose that the stumps are but ten feet apart each way, by no means an excessive estimate in this case, it appears at once that several years must elapse before the new sprouts spread sufficiently to shade the ground. During this time the covering of vegetable mould is dried up and dissipated by the sun and wind, and the ground becomes more or less thickly covered with grass. Heavy lower branches formed on the young trees in early youth live on for years during the comparative isolation of the individuals, and when they are finally killed by the shade of the upper branches they are so large that their rotting stubs persist for years on the trunk, and in the end form dangerous centers of decay. The space between the stumps is often more or less scantily occupied by young seedlings soon after the cutting of the old wood, but the rate of growth of coppice shoots is so much faster in early youth than that of seedlings that it is comparatively seldom that one of the latter succeeds in forcing itself into the upper story of growth. Before cutting, the shade of the old sprouts is usually too dense to permit much advance growth beneath them. Seedlings from this source, which would be better fitted to withstand the competition of the sprouts, are consequently rather scarce. As a result the same stools serve for generation after generation of sprouts.

While I cannot yet speak with certainty on this point, I am inclined to believe that a considerable part of the disease so common in the older coppice woods is due to this lack of new blood.

Another unfortunate result of the small number of stools is the very irregular distribution of the trees. There is probably a considerable loss from this source, because the dominated trees, unevenly distributed and of uneven size, are often valueless for that very reason. It is often not worth while to cut from year to year a few poles scattered here and there, whereas a regularly distributed crop of

thinnings, such as proper management secures, would pay for itself under the same circumstances merely from the convenience and economy of handling it. And in addition there is the marked improvement of the remaining trees which is the natural result of good thinning.

The reasons against the present form of coppice forest are, then, the deterioration of the soil, the shorter life and greater liability to decay of the coppice shoots as compared with seedling trees, and the defects in the trunk which arise from the open condition of the forest in early youth. On the other hand, from such information as I have been able to gather, I believe it probable that the relative scarcity of saw timber, and the great supply, limited demand, and consequent low price of the product of small trees, will be found on examination to furnish a sound financial reason for allowing forest trees in northern New Jersey to attain a greater age.

It is probable that one form of the group system, a method of management which consists in cutting a small hole in the forest and gradually extending it as the uncovered area is seeded by the surrounding trees, would be one of the kinds of treatment most applicable to these forests for the production of large timber. More careful study is required, however, before a definite opinion can be pronounced upon this point. And in any event the present method, while it is not by any means the best attainable, still does not result in the immediate destruction of the forest. In northern New Jersey the question is not so much that of saving the forest, since that is already being done to a very considerable extent, but of the proper treatment of it. Adequate fire protection must here be the result of proper forest management. In southern New Jersey fire protection must come first.

Before passing on to consider the forest south of the Long Branch-Salem line it may not be out of place to mention three general rules, of easy apprehension and application, which apply to all the hardwood forests of New Jersey. These are, first, never cut out underbrush unless it is actively interfering with the live crowns of the trees above it; second, in thinning a forest, never allow light enough to reach the ground to produce a growth of grass; third, thin by the top only. Trees which do not interfere with each other in the crowns do not interfere at all.

The woodlands east and south of the Long Branch-Salem line pre-

sent a totally different set of problems. Here the one vital and immediate question is the prevention of fires. Any attempt at the proper treatment of these forests must depend altogether on the successful elimination of this source of danger. Once that is accomplished, the prospect for producing timber at a profit in southern New Jersey is perhaps better than in the northern part of the State, at least as respects a certain class of lands. But in the absence of fire protection forest management is here impossible.

The forest in this part of the State was originally composed of coniferous trees to the more or less complete exclusion of broad-leaved species. Conifers are still distinctly the predominant trees of the region, but the action of fire has served to increase the proportion of hardwoods to a very considerable degree. The Oaks and the Chestnuts, by which the Pines and Cedars are often succeeded, sprout freely from the stump, and therefore very often survive in spite of the deadening of the whole growth above ground by fire. The Pitch Pine also sprouts from the stump, but the shoots are slender and short-lived, and never succeed in forming trees. Neither the Short-leaf Pine nor either of the Cedars comes up again from the old roots when the trunk of any individual is killed.

The action of fire is three-fold. It burns up the accumulation of vegetable matter on the ground, which is the manure of the forest, weakens or kills the trees themselves, and exerts a powerful influence on the composition of the succeeding crop. In all three of these directions its influence in southern New Jersey is for harm. So serious and so insidious is the damage done when a forest-covered swamp with peaty soil takes fire, that I saw in November near Weymouth, in Atlantic county, a piece of swamp with the forest on it completely dead, and yet with no trace of fire visible anywhere for more than a foot above the ground. Already the trees had begun to fall before the wind. By the end of the winter it is likely that not a standing tree will be left upon this area, which is now, to the casual glance, a prosperous bit of woodland. The fire which did this damage occurred in September and October of this year and burned for six weeks.

Effective measures against fire in southern New Jersey must consist in the construction of fire lines and the dissemination of knowledge about them. The scheme outlined by Mr. John Gifford in his paper on the forest conditions of southern New Jersey in the report of the Geological Survey for 1894 goes to the root of the matter at once

when it proposes that all public roads should be converted into fire lines.

The cutting and maintenance of roads or fire-lines on the sandy soil of this part of the State will be a matter of comparatively small expense. To clear an area on each side of the public roads, many of which are mere wheel tracks through the woods, so that the barrier to fire would range in width from 40 to 60 feet according to the height and density of the growth on each side, would reduce the danger from this source to a marked degree. Such fire-paths not only serve to check the fire in themselves, but they afford invaluable lines of defence from which to start back-fires and otherwise to resist its progress. It seems evident that the effectiveness of fire-lines combined with moderate watchfulness is not adequately realized. The same fire problem, under not less difficult conditions, has been successfully solved in British India by means of them.* At first the general public opinion, there as here, was that the fires could not be stopped, and that it was useless to attempt it. But now that the thing has been done, the sentiment of the people, once indifferent or even hostile, is in hearty sympathy with fire protection and keenly aware of the benefits which they derive from it.

An example, which is always the most effective way of teaching, would probably do more to bring the practicability and usefulness of fire protection to the attention of the owners of woodlands in this region than any number of circulars or reports. Nevertheless, and perhaps also as a means to this end, I believe that the extensive circulation of a succinct statement of the damage fires are doing, the way to fight them, the construction, location and cost of fire-lines (with diagrams), and the results of fire protection, would be exceedingly useful. Such a statement would unquestionably influence the public mind, and as soon as public sentiment is sufficiently alive to compel effective and united action against fire on the part of the railroads, a very large part of the battle will have been won.

As soon as a reasonable degree of safety against fire has been secured south of the Long Branch-Salem line the question of forest management for profit will become important. The elements of success in this direction are present here, over considerable areas, to an unusual extent. White Cedar (*Chamæcyparis thyoides*, L.), one of the most valuable timber trees of eastern North America, grows rapidly,

* Where not less than 24,000 square miles of forest are successfully protected against fire every year at a cost of less than $3 per square mile.